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ABSTRACT

The primary goal of this collection of classroom activities is to produce environmentally-aware citizens. The skills and concepts taught through use of the kit are intended to permit the teacher to integrate diverse concepts of the environment into classroom teaching. Activities are divided into three main segments. The first segment, Ecological Concepts, considers an ecosystem. The second segment, Pollution Activities, deals with the impact of human beings on an ecosystem. The third segment, Outdoor Activities, suggests a set of problems which students can investigate outdoors. (Author/RE)

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MANUAL FOR THE CBE ENVIRONMENTAL EDUCATION KIT FOR THE MIDDLE GRADES

(Draft Edition)

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FORWARD

This manual, and the kit it was designed to accompany, are still in an experimental stage. We ask that you keep a pen or pencil handy whenever you are using them, and write in the manual any comments, questions, problems or suggestions that you may have. While we welcome extended comments, even just a series of question marks next to any confusing paragraphs would be of great assistance to us. All comments, both positive and negative will help us to turn this prototype into an effective and easy-to-use kit. We thank you for your assistance and your patience.

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INTRODUCTION

In response to growing concern about environmental problems, many elementary and middle school teachers have begun to integrate environmental studies into their classroom activities. This kit and resource guide are intended to help teachers by providing a diversity of environmental materials for classroom use. The materials in the kit, as well as the activities and suggestions in the resource guide, are centered around the ideas of developing an environmentally aware citizen.

In order to achieve this goal, the materials stress the development of relevant concepts, skills, and attitudes. The kit includes activities which will aid students in their development of basic ecological concepts. These "hands-on" activities are intended to help students develop positive attitudes toward the environment and their own ability to deal with environmental problems.

The activities are divided into three main parts. The first set of experiences, Ecological Concepts, centers around the idea of an ecosystem. An ecosystem includes all of the living organisms in an area and the non-living factors which effect it.

The second unit, Pollution Activities, deals with the impact of human beings on a natural ecosystem. A pollutant can be considered to be any substance added to an ecosystem in a quantity large enough to harm organisms.

The third unit, Outdoor Activities, suggests a diverse set of problems, which students can explore outdoors. Activities are included which relate basic ecological concepts to pollution activities. Outdoor activities can be engaged in at any time and can take a variety of forms.

The three units include many different kinds of activities, each of which is aimed at specific conceptual understanding. Students can gain a broad sense of environmental studies by engaging in activities from each of these three units.

The primary goal of these environmental activities is to produce an active, environmentally aware citizen. Tomorrow's citizens must be able to make decisions on environmental problems by using their knowledge and available resources. This kit and guide provides students with a set of experiences that will give them the skills and concepts necessary to make effective decisions.

The Classroom Atmosphere

Most of the activities were designed for students to be actively involved in their learning. Small group discussion is essential to the kinds of exploration and investigation these activities are intended to encourage.

The activities were designed to promote learning about environmental concepts. There seem to be three main factors which promote conceptual learning: interaction of students with materials, interaction between student and teacher, and interaction between students. The activities should promote learning through these types of interactions.

The teacher's role in these activities is to promote curiosity, discussion and further exploration. The activities are best suited for the "discovery method" -- after a period of experimentation during which the students actively engage in exploration, the whole class or small groups should gather together, giving each student an opportunity to express what he has discovered. During this exchange of ideas, new questions will arise that are often the basis for additional investigations. Following the discussion, the class may be able to agree on a joint statement of discoveries which can then be recorded, perhaps on a blackboard or bulletin board. Such a record will be useful later when the class may wish to discuss in greater depth what they have discovered.

Presenting the materials, encouraging students to think, and stimulating class discussion are integral parts of the teacher's role. These elements, combined with a teacher's enthusiasm will undoubtedly increase the excitement and involvement of students in environmental education.

The students' enthusiasm and willingness to investigate problems is stimulated not only by you, but also by other students. If the students perceive the classroom atmosphere as one in which they are free to state their ideas, to disagree with and support one another, they will encourage each other to question and seek answers to questions. Group work in the classroom can and should encourage the sharing of observations and ideas among the students.

During the majority of the activities suggested in this guide, students will be experimenting individually or in small groups. This will allow you to circulate among the students. You will be able to guide the students by listening to them, clarifying ideas, and encouraging them to seek answers. The activities are centered around the idea of allowing students to find answers for themselves. Research shows when a student discovers something for himself, it becomes a part of him which he rarely forgets.

How to Use the Resource Guide and Kit

The kit was designed to provide a large degree of flexibility to teachers who use it. The teacher can make decisions concerning which activities are appropriate for his/her students based on the specific characteristics of the students involved, time and space constraints, the local school environment and organization, as well as the particular interests of the teacher involved. The activities cover a variety of time spans. Some can be completed in one class session, while others may take several class periods to complete. Some may continue long after the kit has been returned.

Many more activities are available than can be completed during the time provided. This is to allow students and teachers to choose activities which appeal to their individual interests and time plans. This flexibility will hopefully allow teachers to add activities that may be more relevant to their specific classrooms, delete activities which may be inappropriate, provide individualized instruction for a diverse group of students, provide enrichment activities for interested students, as well as serving other instructional purposes.

The activities are generally separate from one another. Although each activity could be taught exactly as written, it is not always necessary that you do so. The directions are designed to show you possible ways to organize the activity.

Each major section of the guide includes a variety of activities from which you may select those which are most appropriate for your classroom situation. The activities are designed especially for children. You should avoid teacher demonstrations as much as possible and involve your students in the investigations. Ideally, each student should have a chance to describe, compare, predict, and discuss each activity. Whether the students work individually or in small or large groups is not as important as each child having a chance to actively participate.

You may wish to have all the students pursue the same investigation or to set up learning stations in the classroom with different activities from which the students can choose those that are interesting. You may choose to use the activities in order or they can be shuffled, recombined, or deleted.

It will be necessary for you to look through the guide and decide which investigations you wish your students to pursue. You will need to plan for your specific needs, interests, and time limitations. It is strongly suggested that you choose at least one activity from each section and proceed from ecological concepts ⟶ environmental pollution ⟶ environmental awareness. This order will help facilitate conceptual development. You may wish to emphasize one of these three areas in particular, but students should have a chance to develop concepts in each area.

The charts on the following pages should help you make your decisions.

Resource Materials Included in the Kit and How To Use Them (4)

1. "Earth Cycles" Chart Hang this chart in the classroom. It will be especially useful during the activities on ecological concepts.

2. "Planet Management Game" A useful, fun activity for a small group of students (5-6). See page of this guide for complete instructions.

3. Redwood Controversy An excellent game which deals with environmental decision making. See pages of this guide.

4. "Case of the Bighorn Sheep Filmstrip" Excellent ecological study. Complete instructions included on pages of this guide

5. OBIS Outdoor Materials Extensive outdoor activities with complete instructions included. See page

6. NEED Filmstrips See guide included with filmstrips for specific suggestions. Useful for independent projects for students who are interested in National Parks. See page

7. Experiment Booklets Air Pollution, Water Pollution, Noise Pollution } good reference materials for students who seek additional information and experiments on these topics.

8. Ecopolis Game A lengthy simulation game dealing with the social aspects of environmental problems.

9. Instructor Posters Instructions Included.

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Student Reference Materials

Books

1. Animals and Their Niches
2. The Hidden World: Life under a rock
3. Clean Air - Clean Water for Tomorrow's World
4. Pollution: Examining Your Environment

Booklets

Needed: Clear Air

Air Pollution (A reprint from "Ranger Rick")

Teacher Reference Materials Included in Kit

1. National Wildlife Foundation Guides:

   Change in a Small Ecosystem
   Nature's Part in Art
   Mini Climates
   Transect Studies
   Stream Profiles
   Outdoor Fun for Students

2. Ecology in Your Community

3. Anti-Pollution Lab

4. Booklets:

   NEED outdoor Books
   All Around You

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EQUIPMENT INCLUDED IN THE KIT

(To Be Completed)

Choosing Activities

The following are suggestions for how to choose activities based on time constraints. These are only suggested plans and should be adjusted to specific student and teacher interests.

I. Short Unit (approx. 1 week)

1. Ecological Concepts: A. The Case of the Bighorn Sheep Filmstrip
   B. Food Webs

2. Pollution Activities: A. What is Pollution?
   B. How Much Water Do You Use?

II. Two-Three Week Unit

1. Ecological Concepts: A. The Balance in Nature, any method
   B. The Case of the Bighorn Sheep Filmstrip
   C. Food Webs

2. Pollution Activities A. What is Pollution?
   B. How Much Water Do You Use?
   C. The Redwood Controversy
   D. Energy Problem Cards

III. Extended Unit Any and all of the activities suggested above. In addition, small groups of students might wish to pursue independent projects such as:
   Pland Management Game
   Outdoor Activities

BASIC Activity	ACTIVITY	DESCRIPTION	All equipment provided in kit	Requires going outdoors	Takes longer than 1 class to complete	Can be used by individual students or for indep. study	COMMENTS
	ECOLOGICAL CONCEPT ACTIVITIES						
*	1. The Natural Balance in Nature: What is an Ecosystem?	Students make "mini-aquaria" and observe interaction of plants and animals. Explore concept of ecosystem, food chain	NO	NOT REQUIRED	YES	YES	many alternatives, much enrichment, good for variety of ability levels.
	2. Jelly Bean Ecology	Students explore food relationships by using jelly beans to indicate energy flow	NO	NO	NO	YES	Fun activity for whole class
	3. Food Webs	A whole class activity for students to gain an understanding of food web relationships.	YES	NO	NO	NO	Easy, fun activity
*	4. The Case of the Bighorn Sheep	A filmstrip activity for students to investigate ecological principles. shows what an ecologist does	YES	NO	2 periods	YES	Excellent filmstrip, interesting and informative
	5. Planet Management Game	Students study problem of population on an imaginary planet, using simulation techniques	YES	NO	NO	YES	Game for 5 students at a time
	6. Demonstration of Soil Modification By Earthworms	An investigation into the behavior of earthworms as they break soil down.	YES (except earthworms)	NO	YES	YES	Good activity for indep. study
	7. Growing a Mold Garden	Activity provides students with direct experience with decomposers.	NO	NO	YES	YES	interesting and exciting

Basic Activity	Activity (Pollution Activities)	Description	All equipment provided in Kit	Requires going outdoors	Takes longer than 1 class period to complete	Can be used by indiv. student or for indep. study	Comments
⊛ 1.	What Is Pollution?	Brief introduction to the concept of pollution. Good basic activity	YES	NO	NO	YES	Good basic activity
2.	Pollution and Living Things	An investigation to determine how common household products affect living things	NO	NO	NO	YES	Advance Prep. needed to grow brine shrimp.
3.	Do Detergents Pollute?	Experiments to determine if detergents are pollutants.	YES	NO	YES	YES	Encourages graphing skills
~~4.~~ Not Included	~~Water Pollution Activities: I. Testing a Polluted River II. Judging Water Quality III. Can You Clean Up a Polluted River?~~	~~A set of activities on water pollution. Students create a polluted "river" do tests to judge water quality, and try and clean the water using purification techniques~~	~~YES (few other items, easily obtainable)~~	~~NO~~	~~YES~~	~~YES~~	~~Excellent set of activities leading to understanding of water pollution~~
5.	Cleaning an Oil Spill	Students create an oil spill and attempt to clean it.	YES	NO	NO	YES	Encourages creative thinking
6.	How Much Water Do You Use?	Students study water conservation in their homes by charting their family's water usage	YES	NO	NO	YES	Requires math manipulation
⊛ 7.	The Redwood Controversy	Simulation game to develop environmental awareness of land use problems	YES	NO	YES	NO	Excellent whole class activity
8.	Wastebasket Archeology	Investigation into litter and solid waste problems.	NO	NO	NO	YES	Interesting activity-simulates archeology
9.	Energy Problem Cards	Problem cards to investigate problems related to energy utilization	NO	NO	NO	YES	Excellent for indiv. instruction-Geared to student interest and ability levels.

BASIC ACTIVITY	Activity	Description	All equipment provided in kit	Requires going outdoors	Takes longer than 1 class to complete	Can be used by indiv. students or for indep. study	Comments
	Air Pollution Activities						
10.	What Does Air Pollution Look Like?	Students collect samples of air pollution particles by placing vaseline-coated collectors outside and then examining them.	NO	YES	YES	YES	Especially good in area with industry / traffic
11.	Air Pollution and the Internal Combustion Engine	A method of comparing the relative amounts of particulate pollutants produced by different internal combustion engines	YES	YES	NO	YES	This experiment can be dangerous and must be supervised
12.	What Happens When Garbage is Burned?	Students burn different materials and make comparisons	NO	NO	NO	YES	Excellent, concrete activity
13.	Demonstration of a Temperature Inversion	Simulation of a temperature inversion - cold air is trapped under a layer of warmer, less dense air	YES	NO	NO	NO	Teacher Demonstration

* Basic Activity	Activity	Description	All equipment provided in kit	Requires going outdoors	Takes longer than one class period to complete	Can be used by indiv. students or for indep. study	Comments
	Outdoor Activities						
1.	Outdoor Bingo	Helps students discover diversity of nature by playing game	YES	YES	NO	YES	Fun, easy activity
2.	What can You Find Out About An Organism?	Students make an indepth study of one organism	YES	YES	NO	YES	Fun and interesting
3.	Problem Cards for Outdoor Activities	Increase student's awareness of outdoor environment.	YES	YES	NO	YES	Flexible
4.	Study of a Woodlot	Studying a wooded area in depth, students gain understanding of relationships between plants, animals, and nonliving materials	NO	YES	YES	YES	Excellent, scientific experience
5.	Life on a Rotting Log	Students examine a rotting log closely	YES	YES	NO	YES	Good for interested students
6.	Making a Waterscope	Students make a waterscope to examine underwater aquatic life	NO	YES	YES	YES	Fun, inventive activity. Requires pond or stream

* Basic Activity	Activity	Description	All equipment provided in Kit	Requires going outdoors	Takes longer than 1 class period to complete	Can be used by indiv. students or for Indep. study	Comments
	Misc. Activities						
1.	Nature's Part in Art	Intended to provide closer look at environment by looking at natural objects.	NO	YES	YES	YES	Excellent art activities
2.	Slide-Tape Shows	Students can create slide-tape presentations on local environmental issues.	NO	YES	YES	YES	Exciting for interested students
3.	Environmental Charades	Students play charades showing different environmental problems	YES	NO	NO	NO	Interdisciplinary activity

ECOLOGICAL CONCEPTS ACTIVITIES

Note: Before beginning these activities you may wish to read some additional information about ecological concepts. An informative article, "Ecology - A Definition" can be found at the end of this guide.

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This is an important activity for the development of ecological concepts.

THE NATURAL BALANCE IN NATURE: What is an Ecosystem?

Concept: An ecosystem is all the living organisms in an area and the non-living factors which affect it.

Activity: Studying change in a small ecosystem -- "mini-aquarium"

SPECIAL NOTE: This activity can be extended beyond the suggestions given below. It is suggested that you read the booklet, Change in a Small Ecosystem which is included in the kit for further ideas. Also, the activity "Jelly Bean Ecology" which follows in this guide would help develop the concept of an ecosystem. An additional excellent reference is Ecology in Your Community, p.12-13, which is included in the kit.

An ecosystem includes all of the living organisms in an area and the non-living factors which affect it. In this activity, the students are involved in numerous "hands-on" investigations both inside and outside of the classroom. The students make a "mini-aquarium" and observe the interactions of plants and animals within this system. They seek answers to questions about these relationships and record information about the eventual changes that take place in this system.

During the observations, the students discover relationships about each individual organism as well as about populations of organisms. Students have an opportunity to explore the behavior of individual organisms and to compare behaviors. The activities lend themselves to allowing students to focus on those problems that are particularly interesting to them.

By understanding the natural working of an ecosystem, students will gain the conceptual framework necessary for later understandings of man's impact on it.

Teaching Suggestions:

There are several different methods by which the students can construct their "mini-aquaria." The first method is to have the students actually gather the materials for the aquarium themselves from pond areas near home or school. This is only feasible if time and weather permit. The second method is for the teacher to purchase certain materials from a local pet store or to have students bring them in from the store. The third method is for students to create "mini-communities" using only grass and weeds from the school ground. These materials can be obtained during any weather conditions.

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Method I.

Gathering materials to make an aquarium. (See Change in a Small Ecosystem, p. 4-5). Students go outside and collect living materials from pond communities.

Method II.

An Aquarium from a Pet Store.

The most effective way for students to observe the aquaria is to set up a "mini-aquarium" for each group of 3-4 students. You can use gallon jugs, mixing bowls, large plastic boxes for shoe or sweater storage or mayonaise jars.

Procedure:

1. Wash the containers thoroughly but do not use soap.

2. Fill them with water, letting the water stand at least 24 hours before adding living organisms. This allows chlorine or other gasses to escape.

3. From the pet store obtain the following for each "mini-aquarium:"

   2-3 sprigs Elodea (small green plant)
   1-2 guppies
   3 snails
   ½ cup water containing algae (ask the pet store owner if he has any of this)

None of this is very expensive and should be easy to obtain.

Method III.

A Grass-Water "Mini-Aquarium"

Materials for each teach of students

1 clean glass jar (baby food or larger)
water
1 handful of grass or weeds (just pick some outside)
* hand lenses
microscope (This is essential for activity)

Procedure:

1. Wash and rinse the jar

2. Fill the jar 3/4 full with water

3. Allow the water to sit for 24 hours. This allows for chlorine and other gasses to escape.

HOW IS AN AQUARIUM LIKE AN ECOSYSTEM?

An aquarium has living and non-living parts. Begin a discussion to answer the above question by having students complete a chart similar to the one below:

Interrelationships Between the Living and Non-living parts of an Aquarium		
Living Part	Non-Living Part	Interrelationship
1. Fish	water	swimming breathing
2.		
3.		

Other charts might include interrelationships between the living parts of the aquarium (e.g., fish and snails) or a chart showing the interrelationships between the non-living parts of the aquarium (e.g., air and water).

-How many kinds of interrelationships among the parts in the aquarium did you find?
-Is your aquarium an ecosystem? Why?

Extending the Concept:

You may wish to explore some of the ideas in the booklet, "Ecology in Your Community," p. 36-54, included in the kit.

4. Add a small handful of grass/weeds from school yard.

5. Place jar near sun, but not on a radiator or in direct sunlight.

In several days, micro-organisms will begin to appear in the jars. Students can use microscopes or hand lenses to observe the organisms.

Studying the Mini-Aquaria:

1. Have students make a chart like the one below to keep an accurate record of what is happening:

What's Alive in the "mini-aquarium?"

Date Seen	Name (if known)	Number Seen	Drawing/Description

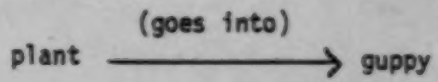
Students can use hand lenses or microscopes to observe those organisms which cannot be seen easily.

2. Students may wish to add other organisms such as crayfish, other fish, plants, snails, etc. Encourage them to do so if their aquarium is large enough.

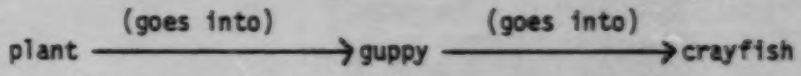
3. Students may want to place some in sunlight, others in the dark, cover some and leave others uncovered to see the effect of sun and air on their mini-aquaria. (Do not cover mini-aquaria with fish or crayfish).

Extending the Concept:

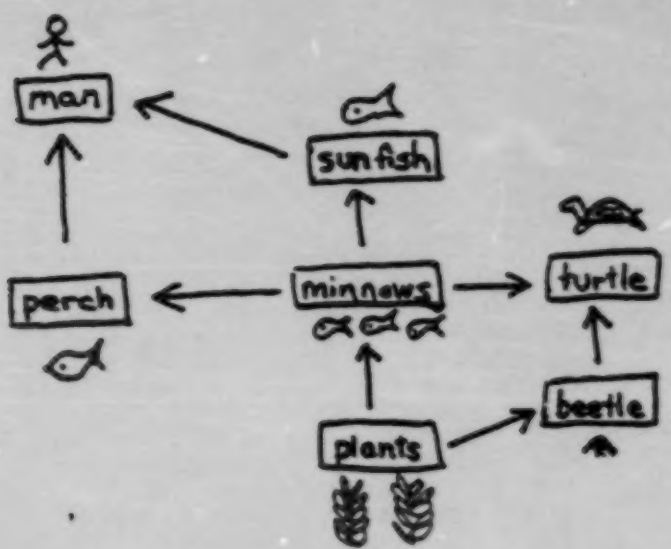
Draw a food chain diagram with the students that explores the idea of food relationships. To draw a food chain, we would indicate the food relationship of a guppy eating a plant as follows:



The phrase "goes into" does not need to be written each time an arrow is drawn, but it helps the students remember in which direction to draw the arrows. The food chain can be expanded as follows:



The students can suggest other food relationships that they are aware of:



This represents several food chains or a food web (See Food Web Activities included in this guide).

1. What organisms in the acquarium are plant eaters? Which are animal eaters?
2. Ask students what the importance of water, sun, air, etc., are to their mini-aquaria?
3. If there was no light on earth, what could live? How long?
4. Is there anything on earth that doesn't depend on light in some way?
5. Develop the concept of an ecosystem with students. An ecosystem includes all of the living organisms in an area and the non-living factors which affect it.

   The basic source of food energy in an aquatic ecosystem (and terrestrial) is sunlight. Plants use the sunlight to TURN carbon dioxide and water into a usable form through photosynthesis. Primary consumers eat the plants. Secondary and tertiary consumers eat the plant-eaters. Decomposers feed on the remains of organisms that die, breaking down their bodies into simple materials that can be re-used by the plants. (See Growing Mold Garden Activities.)

Related Activities:

1. Food Web Activities
2. Change in a Small Ecosystem booklet included in kit.
3. "Jelly Bean Ecology" activity which follows.
4. Wall Chart included in kit.
5. OBIS Packet #III (included in kit) -- Card on Making Snails.
6. Pickle Jar Terrarium Activities and Mold Garden Activities.

Extending the Concept: Independent Investigations:

You may wish to pose some of the following activities to students by writing some of them on the board or putting them on 5 x 7 cards so that students can choose those that are interesting to them. These make excellent activities for homework, enrichment, independent study, etc. They help students refine observation skills.

J. Independent Investigations For Students

#1 How Does a Snail Eat?

What do you think snails eat? Do they have a mouth? Do they have teeth? Eyes?

#2 How Does a Snail Move?

How does a snail move? Which part of a snail moves as it moves? Does it ever come completely out of its shell?

#3 What's in the Aquarium Water?

For this experiment you will need:

1 microscope
1 microscope slide
1 cover glass
1 medicine dropper

Put a drop of aquarium water on a slide - a very small drop. Place a cover slip over it. Look at it under the microscope. Draw what you see.

-How many different kinds of organisms do you think you have seen?
-If you had to name these organisms in a way that describes them, what names would you give them?
-Do you see some things that are not moving? What could they be?

Extra Ideas: Try looking at a drop of water taken from the top, the middle, and the bottom of the aquarium. Which one has more living organisms? What reasons can you give for this?

#4 Invent an Organism

Suppose you are given the task of designing an organism that lives on the floor of the ocean. There is very little or no light on the ocean floor. This particular organism feeds only on living fish. What body parts or special features for getting food would you give your organism? Draw a picture of your animal and then describe how it catches its food and exactly what it eats.

#5 Does a Snail Travel Uphill Faster than Downhill?

Invent your own way to find out how fast a snail travels uphill. (Hint: try having the snail go up the sides of a container.) What did you find out? How did you find out?

-How fast does it go downhill? How did you find out?
-In which direction does a snail move the fastest? Why do you think this is true?

#6 How Does a Guppy Swim?

How does it swim up? Down? What does it do to turn corners? Can a guppy swim backwards?

How do the guppy's fins and tail help it move? Which fins are used for moving forward? In other directions?

Make some drawings or diagrams to show the directions or ways in which guppies swim. What can you conclude about the guppies and their swimming habits?

#7 What in the World is a Gastropod?

Snails belong to the group of organisms called Gastropoda. (It's Greek.) Observe a snail and describe it. Observe its shell, its head, its eyes, mouty, and feet. Now what do you think a gastropod is?

What other kinds of gastropods are there? Describe a few different kinds. Observe similarities and differences between these and the snail.

#8 What Kinds of Animals Eat Snails?

Are there animals in your aquarium or terrarium that eat snails?

Can you think of any other animals that might eat snails? Name some.

Do some library research to find out what animals eat snails. Find out what kind of snails they eat and how they eat them. For example, do they need teeth to chew them or do they just gulp them down.

Extending the Concept: PICKLE JAR TERRARIUM

A terrarium is a wonderful vehicle for studying the basic needs of plants and for understanding the interdependence of plants and animals. Students can make comparisons between their aquaria and terraria.

Materials per Team:

1 large, clear glass jar, such as a 1 qt. pickle jar
Coarse sand, fine gravel or perlite
Soil
2 or 3 small plants, less than 3" tall.
Plants
Animals

Wild plants may be collected easily in plastic bags. Be careful in digging up the plants so that the root systems are not damaged. Suitable plants include moses, pine seedlings, ferns, and ivy.

Commercial plants and cuttings from house plants or home gardens are another source of plants for terraria. Good selections are ivies, fittonia, baby's tears, young palms, peperomias, gloxinia, etc.

Animals which can live easily in a terrarium include land snails, pill bugs, crickets, worms, etc.

Procedure:

The layers described here are scaled to a 1 qt. pickle jar and should be increased or decreased according to the size of the container.

1. Into the bottom of the clean jar pour a half-inch layer of coarse sand, fine gravel or perlite. This is the drainage layer and helps prevent root rot when the soil is too moist.

2. Next add about 1½ to 2 inches of barely moist soil. Use soil from the area which the plants were collected or use a mixture of 1 part sand, 1 part humus and 1 part potting soil.

3. Next, the plants themselves. Two different plants, each small enough to allow a little headroom, should be sufficient for a 1 qt. jar. Select plants of contrasting color, shape or height for variety.

4. Cover the roots and press the soil firmly around the base of the plants. Small rocks or pieces of bark may be added at this point for a decorative touch.

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5. Add a small amount of water so that the soil is just moist but not wet. Be stingy, since too much water is the most frequent cause of failure of terraria. More water can always be added later.

6. Put on the lid (or plastic wrap) and place the terrarium in good light but not direct sun. Once the garden is settled, it cares for itself. The glass should be slightly fogged but not wet. (To correct for too much moisture, take the top off for a few hours.)

Wine bottles of a half-gallon or larger sizes are popular for terraria and can be very attractive. But manipulating plants in a narrow-necked jar is tricky. Use a funnel improvised from stiff paper for pouring the sand and soil, and use tongs or chopsticks made from thin sticks or wooden dowels for handling the plants. Digging and tamping tools can be fashioned by taping spoons or other kitchen utensils to the sticks.

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Related Activities:
The Natural Balance in Nature
Jelly Bean Ecology

FOOD WEBS

Concept: Living things are interdependent with one another and their environment.

Activities: Food Webs.

Food chains are made up of different species that have a feeding relationship -- that is, each species is eaten by the next species in the chain. Several chains linked together form a food web. Energy in the form of food flows through the food web from plants (producers) to animals that eat plants (primary consumers) to animals that eat animals (secondary consumers) and to tertiary consumers.

To draw a food chain, we would indicate the food relationship of a rabbit eating grass, as follows:

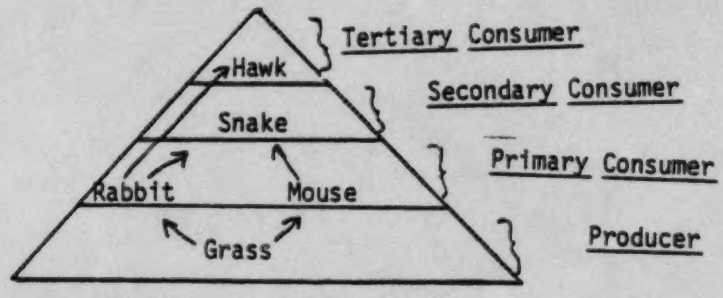
grass —(goes into)→ rabbit

The phrase "goes into" does not need to be written each time an arrow is drawn, but it helps the students remember in which direction to draw the arrows. The food chain can be expanded as follows:

grass —(goes into)→ rabbit —(goes into)→ snake

This is a food chain diagram, a quick way to show feed relationships.

Ecologists find it convenient to use food chains to describe energy relationships. In nature, it is common to find several food chains linked together to form as intricate food web. For example:



Producers - all green plants
Primary Consumers - plant eaters
Secondary Consumers - animal eaters
Tertiary Consumers - animal eaters

The food web exercise will give the students a concrete experience from which they can develop terms and definitions to illustrate various ways organisms are interrelated.

Suggestions for Teaching:

This activity generates a great deal of enthusiasm and interest. It has great flexibility and can be carried out in a number of ways.

1. First have the students research one of the organisms (this may take place the day before).

2. Following the research, the actual activities will take about thirty minutes.

Teaching the Activity:

1. Research:

Either assign or have each student select one organism from the following list. By choosing organisms from the suggested list, you will be able to illustrate most of the common relationships. If you have fewer students than organisms suggested, be sure to choose those with asterisks (*) because they include producers, primary consumers, and secondary consumers.

The names of the following organisms might be put onto 5 x 7 cards and given to each student. The front might serve as an organism name tag, the back might be where students could write the results of their research.

* Coyote	*Vulture	Fly	Spider
* Mouse	*Algae	*Man	Dog
* Rabbit	Oak Tree	*Bacteria	*Cow
* Snake	Cattails	*Mold	Tapeworm
* Grass	*Hawk	*Earthworm	*Corn
Owl	Grasshopper	*Sparrow	Flea
*Snail	*Duck	*Fish	Beaver
*Deer	Beetle	Toadstool	Cat
Raccoon	Louse	*Fox	Wildcat

Others may include: Bear, Grass, Wolfe, Praying Mantis, Skunk, Frog, Woodpecker, and so on.

If the students are not familiar with the word "organism," they may want to add it to their list of new words. A simple definition would be "any living plant or animal."

Have students cut out pictures or make drawings or masks of their organisms. They can wear these during the activity or you may want them to attach their drawings to their desks.

2. Activity:

Materials Needed: 1 large skein of yarn rolled into a ball.
5 x 7 cards
Paper to draw food webs on

Students should arrange their desks in a circle, leaving enough room behind so that the teacher can walk on the outside.

1. Start by asking one student representing a consumer (for example, the coyote) to select from the other organisms one he would eat in order to obtain food. Do not start with a producer (it is the beginning of the food chain). Connect the yarn between the "eater" and the "eaten." Continue connecting "eating" organisms with "eaten" organisms until all organisms are involved in at least one path.

2. After discussion what some animals eat, select a green plant. If students do not realize green plants make food, rather than eat other organisms, you may wish to review briefly how plants use sunlight, water, carbon dioxide, and minerals and produce food and release oxygen. Emphasize that all the other organisms depend directly or indirectly on the producers. Connect the yarn from the plants to organisms that eat the plants.

3. Continue connecting yarn between organisms until several of the have two or more strings. Be sure each student realizes he represents more than one organism and can thereby be eaten by several others. Thus, if a snake chooses the rabbit to "eat," it can also be "eaten" by the hawk.

4. Once you have connected sufficient strings, depending on the number of relationships and concepts you wish to illustrate, have all students tape the strings to their desks on the floor. Students may want to sketch the food web they formed before leaving the circle.

5. When you finish your food web, hand the signs and strings from the ceiling or room lights. This will allow the students to view the food web over a period of time.

Questions for Discussion:

1. How many strings did you have attached to you?

2. Were you consumed or did you consume?

3. What is a food web?

4. Why do living things need other organisms in our environment?

5. What do you think this activity is trying to teach?

6. What might happen if one or two of the strands of the web were destroyed?

7. What might happen if a particular animal (choose one) became extinct?

Extending the Activity:

For additional work, the yarn food web can be used to demonstrate the many effects which occur when one or two "strands" of the web are destroyed. This is a good way to introduce the concept of man's interference in nature. Add man to the web and see how the web is changed. What happens? What would the natural world be like without man?

You may wish to discuss the idea that man has certain responsibilities and obligations to the web of nature.

Enrichment: Food Pyramid Mobiles

Materials Needed:

Pictures of organisms (producers, consumers, decomposers)
Wire hangers, straws, or wood
Cardboard
String
Scissors
Glue

Teaching Suggestions:

Students may wish to construct mobiles which represent food webs based upon their understanding of food pyramids and ecosystems.

Students can research their own webs and construct their mobiles in any way they wish. You may wish to refer to the booklet, Nature's Part in Art, p. 11, which is included in the kit. You will find specific directions for making mobiles.

Discussion Questions on Food Pyramid Mobiles:

1. As you observe your mobile from top to borrom, what is the relationship of numbers of organisms to place in the mobile?

2. Where are the producers? primary consumers? secondary? tertiary?

3. What would happen to your mobile if you remove one of the producers?

4. What would happen if you removed all the producers?

5. What other organisms might be at the "top" of the mobile?

Activity Adapted from: Fundamentals for Understanding Environmental Problems, Environmental Education Project, Topeka, Public and Parochial Schools, 1601. Van Buren, Topeka, Kansas 66612.

An excellent filmstrip showing one ecological study in depth (34)

THE CASE OF THE BIGHORN SHEEP

Concept: Man upsets the balance of nature.

Activity: "Ecology at Work: The Case of the Bighorn Sheep" filmstrip

It is not usually possible to study an entire food web in a classroom. An indepth study of food webs requires time-consuming and careful data recording of each organism present in the web. Students, however, can explore these situations by using case studies. By examining these studies, students can analyze data, draw conclusions, and make recommendations for future action.

Materials Needed: "Ecology at Work: The Case of the Bighorn Sheep" filmstrip.

The filmstrip, "The Case of the Bighorn Sheep" allows students to study about the bighorn sheep. The filmstrip tells of one man's investigations into the causes behind the rapid decline of bighorns in the United States. Students become acquainted with the process of science as it is applied to one ecological study.

Teaching Suggestions:

It would be helpful for you to view the filmstrip before showing it to the students. It is suggested that the filmstrip, discussions, and activities be spread over at least two days.

First day: Show part I of the filmstrip. The following questions might be useful for discussion:

1. Why was this man studying bighorns?
2. Where do bighorns live?
3. Why did the scientist have to "backpack" to study the animals?
4. Why is winter a difficult time for bighorns? How do they survive?
5. Why did the ecologist put neck bands on the bighorns?
6. What could he learn from the radio transmitters?
7. What are some of the reasons that might explain the decrease in the bighorn population?

You may wish to list all the reasons on the board and have the students copy down these hypotheses. After watching the second part of the filmstrip, the students can see how accurate their hypotheses were.

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Second day: After showing the second part of the filmstrip, you may wish to discuss these questions:

1. List all the animals that eat bighorn sheep. What is a predator?

2. What is a parasite? How does the ring worm help cause pheumonia in the bighorn?

3. Why did the ecologist study the vegetation? How did he study the vegetation?

4. How has man caused a decrease of bighorns?

5. What is over-grazing? How does it affect bighorns?

6. Have students look at the list of reasons they made for the decline of the bighorn. How close did they come to guessing correctly?

7. What is an endangered animal? What is an extinct animal? (See pages which follow)

Suggestions for further study:

1. Students might study other endangered animals. They might prepare a full-scale advertising campaign (posters, radio, TV commercials, slides, displays, etc.) which would acquaint other students in the school with the situation.

2. Students might prepare a "class newspaper" on endangered species, featuring puzzles, games, poems, etc.
They may want to create a filmstrip

3. Organizations to contact for further information on endangered species: (See also pages which follow)

Defenders of Wildlife
2000 N. Street
Washington, D.C. 20036

World Wildlife Fund
910 Seventeenth Street, N.W.
Washington, D.C.

National Audubon Society
1130 Fifth Avenue
New York, New York 10028

Office of Information
U.S. Fish and Wildlife Service
U.S. Department of the Interior
Interior Building
Washington, D.C. 20240

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PLANET MANAGEMENT GAME

This activity can be used by a small group of students

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In this game, students run an imaginary planet for 50 years. The game is based on current knowledge of population growth, food production, and the impact of development on environmental quality. The students must cope with the complexity of the population problem.

The Planet Management Game is an extremely effective teaching device because it is highly motivating and it communicates very effectively the concepts and facts about overpopulation which normally would be difficult for students to understand. The players assume realistic roles, face problems, formulate strategies, make decisions, and get feedback on the consequences of their actions.

The game is intended for a group of 5 students and thus can serve as a small-group activity for some students while the rest of the class is engaged in other activities. The game may be confusing to students in the beginning. However, after playing a sample round, students should catch on. You won't need to make sure that students understand every rule before they begin - other students will help those who are slower to understand.

You will need to read the teacher's guide before explaining the game to students. It would be fun and informative for you to actually play the game yourself before giving it to students.

Questions for Discussion after the game:

1. Which projects help raise the index for the environment? population? income? food?
2. What is "desirable" for Clarion?
3. Is a high population good or bad? Why?
4. Is a low food index good or bad? Why?
5. Should the income level be high? Why?
6. Which set of final indexes would you prefer to live with? Why?

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7. If things continued to change in the same way for another 50 years, would Clarion be a good place to live?
8. What kinds of projects would you add to the game to achieve a more desirable endpoint?
9. What strategy would you use to advise other players to use when they play the game?

DEMONSTRATION OF SOIL MODIFICATION BY EARTHWORMS

Concept: Earthworms play an important part in the soil ecosystem.

Activity: Investigating earthworm activity.

Earthworm activity in the soil can increase the total volume of some layers of the soil by as much as 20%. In this experiment, students investigate this effect and other types of behavior, such as tunneling, forming casts (the waste material piled at the entrance of a burrow), soil mixing and the collecting, burial and digestion of surface plant litter.

Materials for Each Team of Students:

Glass earthworm apparatus
2 or 3 earthworms
3 to 5 soil samples (preferably of different colors, but at least one rich in organic material and one made up of fine clay)
A few partly decayed leaves (not oak)

Procedure:

1. Collect the earthworms from an area of rich organic soil or buy them at a bait shop.

2. Make sure that all soil samples are moist but not wet, and then place a layer of one of the samples 5 to 10 cm deep evenly across the bottom of the apparatus. (Place a small amount of the soil on a piece of cardboard and then using the edge of a ruler, gently scrape the soil off into the apparatus.)

3. Using the clay soil next, place a similar layer on top of the first layer.

4. Continue to add each different soil type in turn and try to have contrasting colors next to one another so you will be able to identify the layers later.

5. Place a 5 cm layer of the organically rich soil across the surface and leave an air space of several centimeters at the top of the glass plates.

6. Draw a line on the glass to indicate the upper level of the top layer, and then scatter a few fragments of decayed leaves on the surface.

7. Place the healthy worms in the apparatus and cover the apparatus with a cloth secured by an elastic to prevent the worms from escaping.

8. Observe the activity of the earthworms over a period of 10 to 20 minutes and record their behavior.

9. Place the apparatus in a cool, dark area for 24 hours. (You may need to cover the glass panels with heavy paper.)

10. Observe again, marking any change in the upper level of the soil. Using a centimeter ruler, make the appropriate measurements and then calculate any change in the total soil volume. Trace the total length of tunnels created in 24 hours.

11. Estimate the amount of tunneling that would occur in 1 year at the rate figures for the 24-hour period. Note the displacement of any soil from one layer to another.

Analyzing and Discussing the Data:

1. Between which 2 layers was there the greatest amount of mixing?

2. Compare the amount of tunneling done in each layer. Which layer contained the most tunnels. Which contained the least?

3. Observe any changes in the leaf litter at the surface. Was the litter moved? Buried? Eaten?

4. Continue the experiment, if desired, keeping the soil slightly moist and the apparatus in darkness.

You may wish to ask students to list different ways in which earthworms are valuable to the quality of the soil.

1. Why is the mixing of soil from one layer to another important? (It makes more nutrients available to plant life and may improve soil drainage, aeration and moisture-holding capacity.)

2. Is there some maximum to the increase in soil volume that worms can cause? (Yes. The weight of the soil and the physical qualities of the soil will limit this.)

3. Will an increase in volume occur more likely in upper or lower layers? Why?

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As a followup, students might like to investigate the type of soil preferred by earthworms by taking random samples of different soils in the field and counting the number of worms in each sample. It might also be interesting to try to prove a relationship between the size of the earthworm population in an area and the amount of plant life growing there. Earthworms are interesting creatures, and another fun activity to do with them is to test their reactions to light, soil pH, terperature and soil moisture content.

Adapted from Soil Ecology, William A. Andrews, ed., Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1973.

GROWING A MOLD GARDEN

Concept: Decomposers break down biological materials into substances which can then be recycled back into the environment.

Activity: Students grow a "mold garden" and observe decomposition.

The following activity provides students with direct experience with decomposers, particularly molds. It is hoped that this activity will demonstrate the importance of molds and bacteria in a food chain. Through the action of such decomposers as molds and bacteria, complex biological substances are broken down into water, carbon dioxide and other simple inorganic compounds which may then be recycled into the environment. These concepts can be used to help students understand the process of recycling.

The activity doks not require a great deal of time and can be set up and watched by students while they are engaged in other activities.

Materials Needed for Each Student or Team of Students:

- 1 glass jar (8 oz. size or larger)
- paper towel
- hand lens
- plastic wrap
- materials for garden such as: cheese, fruit, flowers, bread, pieces of cloth, string, chewing gum, cigarette butts, pennies, etc. (See list below)

Teaching Suggestions:

1. The gardens can be made by each students or team as described below. In addition, one large garden can be made in a large glass aquarium or other transparent container. This "class" garden might contain some of the materials that may be too large for the student gardens.

2. Students should be encouraged to bring in various items that they are interested in observing in their mold gardens, such as:

dead insects, fish	metal
pieces of cloth	chewing gum
string	cigarette butts
fruit, vegetables, cheese	stryrofoam
crackers, bread	pennies
feathers	flip top can tops
leather	seeds
shells	paper
rocks	etc.

3. Have students select which items they will use in their mold gardens.

Procedure for the Students:

1. Fold a paper towel into quarters and wet it so that it is moist but not dripping.
2. Place the paper towel in the bottom of a glass jar and add 2 or 3 samples of materials. (They shoujld be small enough to fit easily into the jar without being cramped.)
3. Leave the jar open to the air for at least 5 minutes and then cover it with a lid or plastic wrap.
4. Store the gardens in a warm environment away from strong light.
5. Observe the jars daily for 5 to 10 days and record any changes in color, odor, and general appearance.
6. Students might make a data chart to record information about the mold garden such as:

KEY:

Amount of Growth = 0 - no mold
1 - slightly moldy
2 - some mold
3 - very moldy

Item put in Garden	Date	Amount of Growth					

Observing the Mold Gardens:

1. You will undoubtedly wish to discuss the observations the students are making such ad odors, mold development, growth (change in size), comparison of mold development on different substances, color and variations of molds and bacteria, and changes in texture and consistency of some substances.

2. Some students may want to observe various molds and bacteria with hand lenses or microscopes. Caution them not to touch the molds and remind them to wash their hands when they have finished their observations.

   By examining some of the fuzzier molds with a hand lens, students may be able to see the reproductive structures of the mold. These are called sporangia and look like capsules on stalks. Each sporangium when ripe releases thousands of spores into the air. Each of these can grow into a mold under favorable environmental conditions.

   Two of the most common types of mold are the bread mold Rhizopus, which first appears as a grayish-white network on the surface and later turns black, and Penicillium, the blue-green mold commonly found on rotting oranges. Penicillin, the antibiotic is formed from this mold. Perhaps your students can think of other useful molds.

Questions for Discussion:

A. Predicting the Outcome:

1. Which object do you think will mold first? Why?

2. Do you think one kind of mold will be more common than another? Which?

3. Do you think some of the items will not mold? Which?

B. Analyzing the Data and Drawing Conclusions:

1. Why do you think the mold grew where it did?

2. Was an odor produced? Why do you think there was an odor?

3. Did some items not mold? Why do you think this was so?

4. Which items decomposed the fastest? Slowest?

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5. The term biodegradable refers to any substance which can be broken down by living things. Which items in the gardens were biodegradable? Which were non-biodegradable?

6. What is the advantage to the environment of using biodegradable items?

Extending the Concept -- Landfill and Solid Waste Disposal:

You may have a landfill site nearby and wish to visit it. Or, you may wish to have students who are interested do some research about landfill. Some questions to explore and discuss with the class:

1. What is "landfill?"

2. How is a landfill site similar to the mold garden experiments?

3. What do you think happens to garbage and trash that has been buried? Can you think of a classroom experiment to explore these ideas?

POLLUTION ACTIVITIES

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This is an important activity for the development of the concept of pollution.

WHAT IS POLLUTION?

Concept: Pollution: substances that harm the environment.

Activity: What is water pollution?

Pollution is a concept that everyone seems familiar with, although no one seems to know exactly what it means. To begin with, students must understand what pollution is and how it originates. This includes a closer look at man's standard of value and his inability to foresee the eventual outcomes of many of his actions. These ideas are the central theme of the activity, "What is Pollution?"

Students often view pollution as something dead or unnatural. They usually do not see any evidence of the causes of this pollution and therefore often associate pollution with death or destruction. Students might look at a brownish, putrid lake and call it dead. However, in many cases, a "polluted" lake or river, is actually teeming with living organisms. The "pollution," however, has caused a disruption of the normal balance of the natural population, killing some organisms and causing an overgrowth of a usually undesirable organism. In this activity, a pollutant is considered to be any substance added to an ecosystem in a quantity large enough to harm organisms. This activity should serve as a brief introduction into the concept of pollution. As an extension of the concept, students can them explore other pollution topics in depth, such as water, air, noise, and solid waste.

In the activity, students observe the affects of pollutants to water over a period of time.

Materials Needed for Activity:

For each student or team of students:
Pollutants: soil
- ~~iron oxide~~
- egg (dehydrated would be best)
- ink or food dye
- motor oil (used is best)
- insecticide
- etc.

- toothpicks
- eye droppers
- 6 paper cups with small amounts of pollutants
- labels for jars
- 7 baby food jars (or plastic cups)

Introducing the Activity:

Begin this activity by asking the class what they think pollution means. Write all their ideas on the board. Envourage the class to bring in newspapers and magazine articles concerning pollution. You may want to put these on your bulletin board, or have students make notebooks.

Procedure for Teaching the Activity:

1. Gather all the pollutants together and arrange the pollutants in paper cups or other small containers. Label them.

2. Give each student or team of students 7 baby food jars or plastic cups and have them label them according to the pollutants to be added:
   1. soil
   2. iron oxide
   3. egg
   4. ink or dye
   5. oil
   6. insecticide
   7. water (nothing is to be added to this jar)

3. Fill each of the labeled jars 3/4 full with tap water.

4. Have students add a small amount of pollutants to each jar. Use toothpicks to add a "tipfull" of each dry ingredient (use different toothpicks for each one). Add one drop of the liquid pollutants. (Clean droppers between use.)

5. Using clean toothpicks, stir each solution for 1 minute.

6. Allow each solution to stand for 10 minutes.

7. Have students compare each solution with the cup of clear water and note the differences. You may wish to have students use a chart like the one below:

Pollutant	Color	Odor	Sediment	Anything Else?
1.				
2.				
3.				

8. You may also wish to have students cover the jars and put them aside for four days. They may note any changes on similar charts.

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Questions for Discussion

1. How do you think the pollutants in this activity might resemble those found in our environment?

   -soil is often washed into water as runoff particles. (you may wish to discuss erosion)

   -iron oxide is a discoloring agent that can come from iron pipes or from wells or runoff in iron-rish soil areas.

   -egg represents organic pollutants such as food wastes that act as nutrients for bacterial and fungal growth. Egg which is allowed to decompose for several days will produce an unpleasant odor due to the release of hydrogen sulfide.

   -ink or dye are complex compounds often released by industries as industrial dyes.

   -oil is frequently found in our waterways due to oil spills from tankers or oil drilling accidents.

   -insecticides may wash into water from agricultural spraying operations. Sometimes they are sprayed directly onto water to kill mosquito larvae.

2. Which of the pollutants do you think could be removed from water most easily?

   -generally, solid pollutants such as soil can be removed most easily. These ideas will be investigated in "How can you clean up a polluted river" activity which follows.

3. Which of the pollutants do you think would be most harmful in water? Which least harmful? Why?

   In general, pollutants such as egg, oil, and detergent can make water undesirable for drinking, swimming, washing, or industrial use. Oil, insecticides, and some dyes are dangerous to water organisms. Dirt and iron oxide are a nuisance because they can stain clothing and give water an unpleasant odor, taste, and color.

4. Which solutions changed most after four days? Why do you think this happened?

5. How can you define a pollutant?

   A pollutant is considered to be any substance added to an ecosystem in a quantity large enough to harm organisms. You may wish to discuss with students whether one pint of oil added to a fish aquarium (20 gallons) is a pollutant versus one pint of oil added to the Atlantic Ocean.

Extending the Concept

The whole class or individual students may wish to examine a body of water in the local community to find out what pollutants are washed or dumped into it.

-Is the water polluted by sewage?

-Do any factories discharge waste into the water?

-Do pesticides or fertilizers pollute the water?

-Are any pollutants added by mines or power plants?

-What is being done to prevent pollution in your community?

Students may wish to write to the U.S. Department of the Interior to obtain a copy of the water pollution regulations. Students may also look in newspapers and magazines for articles about investigations and conferences which have led to changes in water standards.

Some students may wish to research local laws which regulate water standards.

POLLUTION AND LIVING THINGS

Concept: Pollution: substances that harm organisms.

Activity: What is the effect of certain substances on brine shrimp?

Students have an opportunity in this experiment to discover how common household products affect living things. The students should have a short time to investigate the normal behavior of brine shrimp so they can make comparisons. In this activity, the students should be free to choose any chemical or household product to determine its effect on the brine shrimp. Some possible suggestions are: paint, mouthwash, detergent, vinegar, ammonia, fertilizer, and other products that enter the environment as a result of man's waste disposal.

Instructions for Raising Brine Shrimp:

Brine shrimp are tiny marine animals, commonly used for fish food. Their eggs will remain viable even though dried and stored for long periods. Brine shrimp are easily raised and require very little attention or care.

Eggs placed in solutions of non-iodized salt will hatch within twenty-four to forty-eight hours. The hatched brine shrimp are orange and extremely small. The basic recipe for hatching brine shrimp is:

> One tablespoon of marine salt in an 8 oz. cut of water with a very small pinch of brine shrimp eggs sprinkled on top.

Materials Needed for Each Team of Students:

petri dishes
brine shrimp (hatched)
eye dropper
hand lens
possible pollutant (vinegar, mouthwash, paint, detergent, ammonia, fertilizer, etc.)

Introducing the Activity:

You may wish to ask students how pollutants such as paint, mouthwash, detergent, vinegar, ammonia, and fertilizer get into an aquatic environment. All the pollutants except the fertilizer are generally flushed down the drain by man, enter the sewage system and are ultimately dumped into a body of water. Fertilizer enters

bodies of water by run-off from agricultural processes. Fertilizer is applied to the land and rain can wash it off into a nearby pond or lake. Living things are in some way affected by these pollutants -- in this experiment, the students test the reaction of brine shrimp to the chemicals.

It would be interesting to have students try to predict which of the pollutants being used might have the most dramatic effect on the brine shrimp and why. Students might write their predictions down and later compare them with their results.

Instructions for Students:

1. Put 1 dropperful of newly hatched brine shrimp and water into each petri dish being used in the experiment.
2. Add approximately 5 drops of pollutant to one petri dish (or vary the concentration of drops by using different petri dishes). Leave one petri dish alone by not adding pollutants.
3. Mix gently, record the time.
4. Use a hand lens to observe the shrimp for the next 20 minutes. Compare the two petri dishes.
5. Note any changes that occur and record the time.

Analyzing the Data: Questions for Student Discussion

1. Describe how your shrimp looked initially. How do they look now?
2. How similar are your predictions and your results?
3. What effect did your pollutant have on the shrimp?
4. Why did you leave one petri dish without any pollutant?
5. What effect do you think your pollutant might have on a fish in a lake or pond?
6. How do common household products affect living things?
7. How does mouthwash get into the ecosystem?
8. Have there been any local fish kills or damage to plants because of chemical pollution? You may wish to research this.

Extending the Concept:

Have some students try the same experiment with different concentrations of pollutants. Try it with plants or algae. Try the experiment with different organisms such as fish or earthworms. Students may want to chart their experiences over a long period of time.

Do Detergents Pollute?

(55)

ices that harm the environment.

: Do detergents pollute?

In this activity, students perform an experiment to determine if detergents are pollutants. Students grow radish seedlings and determine the effects of detergents on the growth of the seeds.

Time Required: One class period, followed by a two-day waiting period, then an additional class period.

Materials Needed for Each Team of Students (or each student)

3 plastic petri dishes
3 pieces filter paper (7cm)
1 eyedropper
1 small cup with detergent mixture (Wisk)*
30 radish seeds (you may wish to try other kinds of seeds)

*You should try to use a detergent containing phosphates. Wisk was found to give acceptable results for this experiment. You will need to make a mixture of detergent and water by adding 50 drops of Wisk to 100 ml. of water (use the beaker for measurement).

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Instructions for Students:

Explain the following procedure to the students:

A. Place one piece of filter paper in the bottom of three petri dishes.

B. Cover bottom of each dish with a small amount of water.

C. Add 10 radish seeds to each dish.

D. Label the top of the dishes 0 drops, 4 drops, and 10 drops.

E. Using the detergent in the small cup, add the correct number of drops of detergent with the medicine dropper.

F. Cover the petri dishes and put them in a warm place with good light, but not directly under a lamp.

Followup: Students should collect data from the experiment after approximately 2 days. It might be very useful to have a class discussion concerning the best ways to record the data. The class should suggest some appropriate data charts. Here is a possibility:

The effect of _ detergent on Radish Seeds:

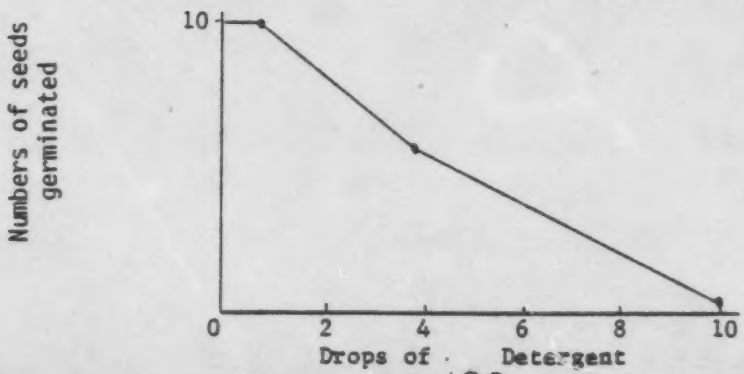
drops of detergent	number of seeds germinated
0	
4	
10	

You may wish to combine the team data into class data.

Analyzing the Data:

Ask the class if they can think of a good way to compare the data they have recorded. They might suggest graphing it. Appropriate graphs might be:

Detergent and Radish Seeds Germination
After Two Days



Students should graph the data and begin to analyze it. They will probably need assistance in making conclusions.

The results of this experiment usually show a decrease of seeds germinated with increasing detergent. However, this is not always the case, and students should analyze whatever class data is obtained.

Conclusions:

Here are some questions you might ask to help students make conclusions:

-- Did ten drops of detergent affect the seeds differently than 4 drops? Than 0 drops? How?

-- What do you predict would happen if you added 15 drops to the seeds? (Some students may want to test their predictions.)

-- Is detergent a pollutant for radish seeds?

There are many implications of this experiment. You may wish to ask students to try to find out what is in Wisk detergent. Ask students if they think detergent can ever affect radish seeds planted on farms. How? Some students may wish to explore such topics as sewage and waste water treatment.

You may wish to ask students to try this experiment with different detergents. Each group of students could choose their own detergents to experiment with. If a powdered detergent is chosen, have students mix up a very concentrated solution to try the experiment with.

Enrichment:

Another interesting variation of this experiment is to do the same experiment using algae in the petri dishes instead of seeds. Algae can be obtained from many local water sources, aquariums, as well as biological supply houses. Frequently, when detergent is added to algae in increasing concentrations, there is an increase in the algae growth. The phosphate in the detergent acts as a fertilizer. This has significant implications for water pollution problems. When excess detergent enters a body of water, it can cause an "algal bloom," making the water unfit for health reasons and recreation uses.

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CLEANING AN OIL SPILL

Activity: Can you clean up an oil spill?

Concept: Water has unique physical and chemical properties.

When large amounts of oil are suddenly spilled into bodies of water, actual catastrophies can occur where large numbers of birds and fish can be killed, beaches spoiled, etc. Oil causes damage in several ways. Generally, the spill consists of crude oil that fouls everything it touches, including sand, water birds, and fish. With their feathers coated by oil, the birds cannot fly and lost most of their buoyancy. By trhing to clean their feathers, the birds are often poisoned by the oil. Fish die by the millions. Plankton, the small organisms that fish feed on, are destroyed.

In this activity, students create an "oil spill" in the classroom. In the experiment, the students should consider their containers to be actual rivers -- i.e., they cannot "clean up" their oil spill by filtering the water since in a real world situation, you cannot filter all the water in a river.

Materials Needed for Each Team of Students:

6 large plastic containers (or glass beakers, baby food jars, plastic cups, etc.)
1 medicine dropper
oil (olive, cooking oil, 3-in-1 oil, motor oil, etc.)
salt
bird feathers

Introducing the Activity:

Begin the activity by asking students what an oil spill is. How does it happen? What are some of the problems associated with a spill?

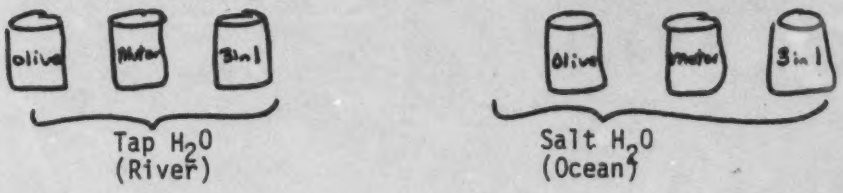
Students might initially suggest ways that an oil spill might be cleaned up. Some of these can be used in the experiment which follows.

Directions for Individual Students or Teams of Students:

1. Fill six containers with tap water. Add a pinch of salt to three of the containers.

2. Using the eye dropper, add 5 drops of oil to each container. (Use three different kinds, 5 drops in fresh water, 5 drops in salt water):

It is possible to do this activity with only one type of oil.



3. Label containers.

4. Write down what happens when the oil is added.

5. Dip bird feathers into the oil-water mixture. What happens? Why are oil spills threatening to bird populations?

6. Using sponges, paper towels, spoons, or any objects you want, clean up oil from the water samples. Record what methods and materials seem to work best. Write a report on the success of your method.

Analyzing the Data and Questions for Discussion:

1. What factors must be taken into account when trying to clean up an oil spill? (e.g., size of body of water, salt water, fresh water, money, time, wildlife, etc.)

2. Are the same methods of oil removal equally effective on fresh and salt waters?

3. In addition to the type of water, what are some other factors which may differ in fresh water and salt water situations?

4. Can the method you devised to clean up the oil spill be used on a large scale, as if your "river" had a 25-mile surface area?

Extending the Concept: Enrichment

1. Do libraby research to investigate examples of catastrophies that have occurred such as Coney Island, Santa Barbara, etc. Students may want to report on the various methods that were used to clean up after the spill.

2. Additional Investigation:

(Reference: Anti-Pollution Lab, Sentinel Books, p. 93).

Materials Needed:

2 flower pots
soil for the pots
1 oz. grass seed
water
100 ml. ~~graduated cylinder~~ Beaker
100 ml. automobile oil

Directions:

1. Fill the two flower pots with soil and sprinkle grass seed on the top.

2. Keep the flower pots in a sunny location. Water every two days until the grass is about two inches tall. This should take about three weeks.

3. Sprinkle 100 ml. of oil on grass in one of the flower pots. Leave the other pot alone.

4. Continue watering the plants every two days.

Analyzing and Discussing the Data:

-What happens to the grass in each of the two flower pots?
-Why do you think this happened?
-What could be done if there was an oil spill onto a grassy shore area?

HOW MUCH WATER DO YOU USE?

Concept: Water is an important natural resource that must be conserved.

Activity: Measuring water consumption in the home.

"Except for the air we breathe, water is probably the environmental factor most important to human survival. One adult human being requires about 2,500 gallons of water a day for his maintenance, including water actually consumed and that needed to grow his food. In the United States, our present water consumption exceeds 15,000 gallons per person per day; we use it to produce clothing, to flush toilets, to manufacture goods, and to air-condition our homes, offices, and other buildings, as well as numerous other personal uses.

The enormous amount of water required to grow a plant, which is multiplied many times to grow an animal, should impress on us all our utter dependence on water. It is estimated that around 1,000 pounds of water are used to produce 1 pound of milling wheat, or 1 pound of bread. A gallon of water weighs 8.3 pounds; 300 gallons are therefore required to make 2½ pounds of wheat flour."

(Environmental Education in The Elementary School, Sale and Lee, p. 86.)

Teaching Suggestions:

This activity has three stages. The first is an introductory phase (one class period). The second may be done for homework and is the data collection phase (24-hour period). The third phase is the discussion phase and includes analysis and synthesis based on the data collection.

I. Introductory Phase

You might begin this unit by having each student get a cup of water from the tap and place it in front of him. Tell the students to imagine that a visitor has just arrived from Mars who has never seen water before and wants to know what it is and why it is important. Have each student write down his description and explanation. When all students have completed this activity, discuss what everyone wrote down. Some questions for discussion might be:

1. What are the main characteristics of water? (liquid, clear, odorless, etc.)
2. What needs to humans have for water?
3. What are the sources of water?
4. What happens to water after we use it?

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5. Why have water problems become so serious?

6. What is the water cycle? (See "Earth Cycles" Wall Chart in kit.)

7. Is tap water safe to drink? Why do you think so? What has happened to make it safe?

II. Data Collection:

Before indoor plumbing and water was piped into our homes, people used an average of 4 to 5 gallons of water per day. Today, the average American uses 60 gallons of water per day. Much of this is water that is wasted simply because the supply is readily available.

Have students keep an accurate record for 24 hours of how much water they use. You may wish to reproduce the charts on the following pages.

Students may have difficulty in understanding that, for most people, a shower takes less water than a bath. Suggest to them to plug the tub and take a shower, than compare the amount of water in the tub with the amount used for a bath.

III. Discussion Phase:

After students have completed their data gathering, have a class discussion to determine the following:

1. What is the average amount of water used by one class member in one day? (Take 10 sample totals)

2. What is the average amount of water used by the class in one day? By the number of people in the school? The county?

3. What indirect ways to we use water that have not been counted in the chart? (Food processing, manufacturing clothes, etc.)

4. Is there an unlimited supply of water on earth? Why or why not?

5. In what ways can we cut down on the amount of water we use? Have students make suggestions. For example:
   -Turn off the water when we brush teeth, shave, etc.
   -Water a lawn late in the day so it doesn't evaporate.
   -Do not let water run needlessly when washing dishes or getting a drink of water.
   -Etc.

6. If taking a bath uses more water than taking a shower, yet you prefer baths, are you willing to change your bathing habits to save water?

7. Are you willing to let your lawn die to conserve water?

Reference: Interdisciplinary Concepts and Activities, Environmental Education Center, Lee County Schools, Fort Myers, Florida.

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How Much Water Do You Use Daily?

Chart I - Water You Use For Yourself

Keep this sheet with you for one day. Make an X each time you use water. Multiply the number of X's times the "average amount of water used" to figure out how much you used in 24 hours.

How You Use It	Average Amount For One Use	Put X for Each Use	Total
taking a bath	114 liters		
taking a shower	76 liters		
flushing a toilet	11 liters		
washing hands or face	8 liters		
getting a drink	1 liter		
brushing teeth	1 liter		
other:	you estimate		
			TOTAL

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Chart II - Your Share of Your Family's Water

Your family uses water for such things as cooking and cleaning. You should figure out your share of that water.

How You Use It	Average Amount For One Use	Put X for Each Use	Total
washing dishes for one meal	30 liters		
cooking a meal	19 liters		
washing clothes	122 liters		
other:			
			TOTAL

Your share = $\frac{\text{TOTAL}}{\text{Number of People in your family}}$ → [ ] Your share

Amount of water you use daily = Chart I + your share of the family's water

= ___ liters/day

This is an excellent activity to develop Environmental awareness.

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THE REDWOOD CONTROVERSY

Concept: Conservation and depletion of natural resources.

Activity: The Redwood Controversy Game.

Materials Needed: Redwood Controversy Game

The Redwood Controversy game is designed so students gain insights into political, goegraphical, and sociological issues which confuse the solution of land utilization problems. The class simulates the senate hearings and debates which preceded the establishment of a National Redwoods Park. The majority of the class members play the role of senators. Each senator is provided with a profile which describes his/her role and places restraints on his/her behavior. Other class members play the role of witnesses representing lumber interests, conservationists, local politicians, federal bureaucrats, and the academic community. Witnesses present their point of view and are questionned by senators.

Teaching Suggestions:

Instructions for the game are included. The game might take 4-5 45-minute periods.

Post-Game Discussion:

1A. How did you feel your role as a senator, etc? What were the issues in your role, as you saw them?

1. What factors should be considered before the government takes private land?

2. What factors seemed to influence the senate to vote for the winning proposal?

3. How similar do you think this game was to a real senate hearing?

4. Before the game began, how did you feel about a Redwood Park? What is your personal opinion now?

5. What environmental problems can you think of in your county which might be similar to the Redwood Controversy?

6. Why should we have national parks at all?

7. How did you like the game? What did you like? What didn't you like? How would you play it differently next time?

Followup: Students may be very interested in what really happened in Congress. In 1968, Congress passed a bill providing for a Redwoods National Park of 58,000 acres at a cost of $92 million.

Additional References: (Not included)

National Geographic, Vol. 126, No. 1, July 1964, p. 1, p. 10.

Readers' Digest, Dec. 1966, pp. 91-96.

An extremely interesting activity on litter and solid waste disposal

WASTEBASKET ARCHEOLOGY

Revised by Myrtle Carlson

BEHAVIORAL OUTCOMES

- **is aware that analysis of a collection of litter yields varying kinds of information when examined systematically.**
- **recognizes that man is a unique litter producer and examines possible solutions to the growing problem of man-generated litter.**

INTRODUCTION In the first activity of this unit students will learn some of the techniques archeologists use by telling a story from refuse found in an office wastebasket. By analyzing a collection of office litter students will compile information from the litter. Students will also analyze the contents of a kitchen waste container. From these activities students may become aware of modern man as a unique litter producer.

Problem-solving methods will be employed by students when making predictions about litter created by modern man, or examining possible solutions to the litter problem, (e.g., recycling, inventing self-destructable materials, etc.). Students will demonstrate their ability to use litter in an aesthetic manner by creating "junk art" from discarded items. Also, students may demonstrate their awareness and concern for litter problems by engaging in group projects (e.g., schoolyard clean-ups, collecting bottles and cans for recycling). In addition, students may utilize research skills by reporting on various topics relating to litter.

BACKGROUND INFORMATION The following information may serve as a guide to assist students who would like to do research on various topics relating to litter.

RECYCLED MATERIALS

Students may explore the types of materials that can be recycled and the methods used to recycle them. They may locate recycling centers in their area, look for symbols on products which are made from recycled materials (e.g., egg cartons, stationery) or recognize the social problems involved in recycling, (e.g., a company that recycles cans might reduce its employment).

LANDFILLS

Landfills are a method of disposing of litter by burying it under layers of earth on low ground. Tell the students that many parks, recreation areas, and housing developments are now built on landfills. La Guardia Airport in New York City was built on a landfill. Students may explore the locations and possibilities for landfills in their area (e.g., old mines, gravel pits, etc.).

INVENTIONS RELATED TO SOLVING THE LITTER PROBLEM

Self-destroying materials, such as plastic bags that dissolve when the food inside them cooks, or plastic containers that dissolve when placed in water have been invented. Edible containers are also being tested.

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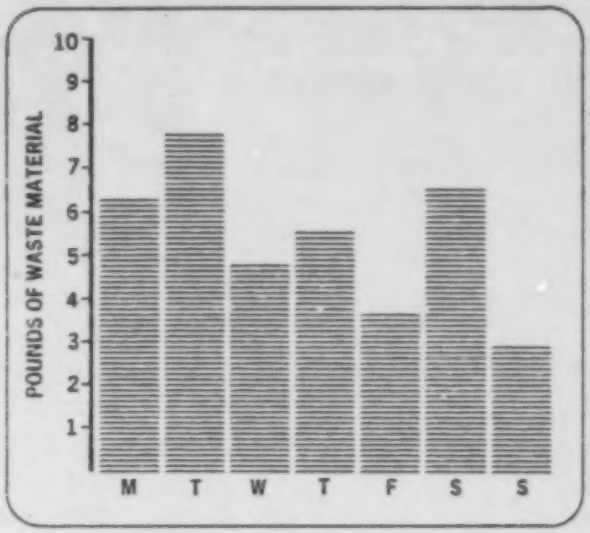
GRAPHS ON LITTER

Students may design bar or picture graphs about some aspect of the litter problem. For example, the amount of litter that each person in the United States throws away each day is about 5 pounds. A class could graph how much litter they throw away each day of the week as compared with a family or an individual. (See Illustration 1.)



Illus. 1

LEARNING ACTIVITY DESCRIPTIONS

MATERIALS:

A wastebasket that has not been emptied for a full day. (Ask the school janitor, secretary, nurse, librarian or principal in advance so they will take the necessary precautions and keep the basket from being emptied.)

Data Sheets (sample sheet is included in the unit)

Plastic or rubber gloves (at least three pairs)

Fruit and vegetable peelings, discarded containers, and metal cans to fill a kitchen waste container

Discarded items for "junk art," (e.g., bottle caps, egg cartons, plastic containers, etc.)

Transparency showing artifacts (Visual I). (For more information about artifacts see: *The First Book of Archeology.*)

Introduce the term "archeologist" to the students and ask them to share their ideas about the work of an archeologist. The instructor should write the students' responses on the chalkboard or on a transparency. Ask the students where they might find more information to verify their ideas about an archeologist. (encyclopedias, library books, periodicals, etc.). Students should support their responses by referring to reference materials.

Use an overhead projector to display the transparency of artifacts (see Visual I). Introduce the term "artifacts" to the students. Explain that archeology is the study of artifacts used by people who lived in the past. Artifacts are the objects that these people used. (pots, baskets, tools, etc.). Many artifacts are not discovered in their entire form. Most often only a piece of an artifact is found. Discuss the different shapes on the transparency and ask the students to speculate what the artifacts should be called.

Tell the students that they are working like archeologists when they read signs that tell the history of ancient civilizations. These signs are the objects left by past civilizations. Using these artifacts, archeologists look for relationships that provide information about the civilizations. Display the visual of an

Illus. 2

archeologist on a dig (Visual II) and discuss the visual. Inform the students they will have an opportunity to try some of the methods used by an archeologist when they examine a wastebasket and write a story of its contents. The story they write will include the events of a person's day. The story will be developed by using clues found in wastebasket litter.

Spend time discussing with the students how an examination of litter in a wastebasket will prove an event happened. The instructor should probe into problems that could arise by asking students what they will do if there are torn pieces of paper. Also, ask them how they will know the time of day that an event took place.

Use an office wastebasket (secretary, nurse, librarian, principal) that has not been emptied for an entire day. Divide the contents into three layers — top, middle and bottom. Ask students which layer represents the earliest part of the day and which the last part of the day. (Illustration 2.)

Remind them that they will have to examine each waste object carefully for clues. At times they may have to piece scraps together.

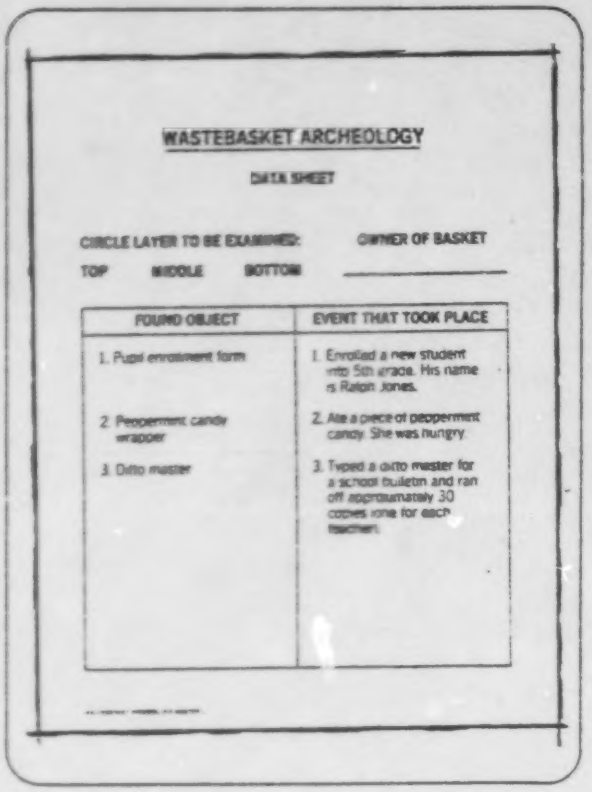
Divide the class into three groups. Each group should appoint a recorder to complete the Data Sheet (see sample sheet in unit).

After the contents of the wastebasket have been divided as evenly as possible into three layers, give one layer (without mixing it) to each group. Be sure the groups know which layers they have.

Instruct each group to analyze each article and use it as a clue. As a group ask them to examine the clues and decide what events took place. Their answers should be recorded on the Data Sheet. As the children work, observe their findings. Encourage the students to write more specific responses than "she threw away a candy wrapper" (she was hungry). The following is a completed example from a Data Sheet.

Found Object	Event that took place
1. Pupil enrollment form	1. Enrolled a new student into 5th grade. His name is Ralph Jones.
2. Peppermint candy wrapper	2. Ate a piece of peppermint candy. She was hungry.
3. Ditto master	3. Typed a ditto master for a school bulletin and ran off approximately 30 copies (one for each teacher).

When the students have concluded the analysis of their litter, return the litter to the basket and assemble the class. Ask them to describe their findings. Ask them if they have any questions about events that other students might help them answer. When they are sure that they have the complete story of the day's events, send a representative from each group to the owner of the wastebasket (if feasible, the entire class should be allowed to go). Have students read the findings about the events of the wastebasket owner's day, starting with the morning. Ask the owner of the basket for information that might have been interpreted incorrectly on the basis of the clues.



WASTEBASKET ARCHEOLOGY

DATA SHEET

CIRCLE LAYER TO BE EXAMINED: TOP MIDDLE BOTTOM

OWNER OF BASKET _____

FOUND OBJECT	EVENT THAT TOOK PLACE
1. Pupil enrollment form	1. Enrolled a new student into 5th grade. His name is Ralph Jones.
2. Peppermint candy wrapper	2. Ate a piece of peppermint candy. She was hungry.
3. Ditto master	3. Typed a ditto master for a school bulletin and ran off approximately 30 copies (one for each teacher).

Illus. 3

Evaluate the success of the activity with the students by asking some of the following questions:

How accurate is this method of finding information?

What other human signs, beside litter, might tell the stories or events of people?

How could this procedure be used to find information about people living in an ancient civilization?

Suggest to the students that they could collect valuable information about litter by examining another type of wastebasket, one found in the kitchen. Ask students how their class could obtain a filled kitchen waste container. A student may volunteer to bring one from home (a kitchen wastebasket should be lined with a large plastic bag that can be sealed).

Employ the same procedure used to examine the contents of the office wastebasket. Divide the contents into three layers and organize three groups of students to analyze the different layers. For sanitary reasons, only one student from each group should handle the litter (be sure that student wears plastic or rubber gloves). An ample supply of newspaper upon which to put the contents of the basket is also useful. The students will record their findings by using Data Sheets. Each group will have a recorder who will report its findings to the class.

After each group reports its findings, the entire class will discuss what items from the kitchen litter could have been made by prehistoric man and what items could only be made by modern man. The instructor should record on the chalkboard or transparency on overhead the students' responses under the following two headings:

Litter made by early man	Litter made by modern man
fruit peelings	fruit peelings
artifacts	plastic containers

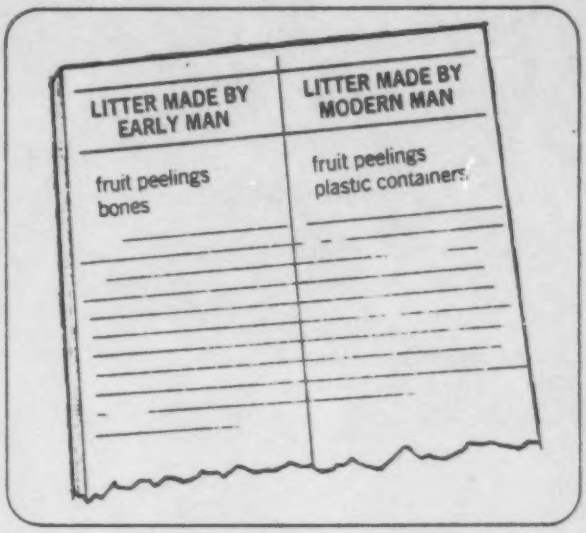
Add to this list other kinds of modern litter that were not found in the kitchen container, (electric razor, toothbrush, automobile). Also, list the litter of early man that is found by contemporary man (flint chips, pottery pieces, crude jewelry, etc.). Point out that artifacts, like much of our modern litter, does not decompose. Ask the students what problems this may make for litter disposal.

Discuss with students the differences between early man and modern man as litterers. Lead students to the generalization that the problem for man to solve is the control of the amount and kind of litter found in our environment. Some possible questions for discussion are:

Are there certain kinds of litter which will not harm our environment no matter how large the amounts?

What kinds of litter in large amounts will harm our environment?

How could modern man be using some of the litter again (recycling)?



Illus. 4

EVALUATION One method of evaluating the students' understanding of the litter problem is by appraising their ability to make predictions relating to litter and its effect on the environment. This activity may be done in panels. A moderator will pose the questions and the students will discuss them. Examples of questions are as follows:

What might happen by the year 2,000 if none of man's litter is recycled?

Possible responses: There would be dumps around all our towns and cities.
We might use up some of our valuable resources.

Students should explain or support their predictions and then verify them by collecting newspaper and magazine articles.

What would happen if, suddenly, you became an inventor assigned to solve litter problems? What would you invent that would really be possible to use?

Possible responses: self-destructing plastics and bottles, make food from paper, make edible containers.

A method of evaluating the students' creativeness to use litter in an aesthetic manner is found in this activity. Students may collect discarded items and organize an art exhibit displaying the collages and sculptures they make with litter. Refer to the following issues of *The Instructor* for art ideas:

The Instructor, April 1969, p. 102.

The Instructor, March 1969, p. 99.

Students can be evaluated in so far as they demonstrate an awareness and concern for the litter problem by carrying out the following project: A Litter-Bug Club formed by the students whose regular activities would be to clean-up some specified area in their neighborhood. This club might also be involved in collecting paper, glass or metal for recycling.

Student reports on litter are another form of evaluation. Topics relating to litter may be researched by the students with bar and picture graphs utilized in the reports.

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Lively description of man's efforts to rediscover his past.

Kubie, Nora B. **The First Book Of Archaeology.** Watts, 1957. Library ed., $3.75 (913) 5-7
A brief survey of archaeology.

White, Anne T. **All About Archaeology.** Random House, 1959. $2.95; library ed., $3.79 (913.03) 5-7
Vivid accounts of various archaeological expeditions convey the thrill of digging up the past.

See the bibliography folder that accompanies this series for references to background information, tests, titles of interest to students, and selected audio visual materials.

WASTEBASKET ARCHEOLOGY

DATA SHEET

CIRCLE LAYER TO BE EXAMINED:

TOP MIDDLE BOTTOM

OWNER OF BASKET _____

FOUND OBJECT	EVENT THAT TOOK PLACE

ENERGY PROBLEM CARDS

Concept: Energy

Activity: Exploring the Energy Crisis

A popular term being used today is "energy crisis." It is fast becoming a daily concern. Gasoline prices are rising, as are prices for electricity. Every day there are more cars on the highways and they all consume energy. Pollution control devices which are now required to reduce air pollution increase the amount of gasoline used. Americans are demanding more and more products due to improved technology. Production and use of all these products are placing a strain on our energy reserves.

One half of all the energy consumption in man's history has been in the last 100 years. Most of our old resources being being depleted and we are just beginning to understand how our lands, air and water have been affected by indiscriminate industrial and technological "progress." We have yet to use efficiently new economically viable and non-polluting sources of energy to maintain the standard of living. The future remains uncertain. There seem to be three alternatives:

1. We could go back to a simple, less technological society in which our bodies' energy do work with help from natural forces.

2. We could try to discover means to harness new and different types of energy to continue to support the complex society we have developed.

3. We could voluntarily conserve the energy sources we have available today and avoid the waste.

Energy Crisis Problem Cards:

You will need to copy these onto cards for the class.

These cards are reproduced on the following pages. Students can shoose a card that seems interesting to them and pursue the activity. Students might work individually or in small groups. A wide variety of activities are included to allow students to choose problems suited to their abilities and interests. These cards make it possible for several types of activities to happen in the classroom at the same time, making activities individualized to meet the specific needs of students. Students should also be encouraged to make up their own cards.

The problems posed on the cards are open-ended in order to have room for student inquiry and creativity. The self-directed, spontaneous process the students go through in their discovery and investigation is usually far more important than the specific answers they find. Students may not come to any "correct" answers. Rather, they should be encouraged to experiment, observe, and draw conclusions.

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Card 1

Take your family's electric bills for a period of three months. Find the number of kilowatt hours (KWH) used on each bill. How much electricity does your family use in one month?

Start a family project to reduce the amount of electricity used. Compare your electric bills after you have started the project.

Card 2

Let your imagination go wild! Develop an ideal system for producing energy for use in the future.

Card 3

Get permission from your principal to interview the school custodian and have him explain how he conserves electricity and fuel in the school.

Card 4

Can you trap the sun?

You will need:

2 tin cans of equal size (remove top lid)
2 science thermometers
2 cardboard lids to fit the cans
lamp (optional)
black flat paint

1. Paint the outside of one can black
2. Cut a hole in each lid just big enough to put the thermometer through and hold it securely in a vertical position.
3. Fill each can with water and measure its temperature by putting the lids with thermometers on the can.
4. Put the cans in a sunny window for 4-5 hours or shine a lamp on the cans for one hour.
5. Measure the temperature of the water in each can.

--Which can has a higher temperature? Why?
--Can you use any of these ideas for inventing a solar heating system for water?

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Card 5 -- Which Way Should You Travel?

The following chart compares three kinds of transportation: planes, cars, and trains. The plan and train each carry 360 people. With 4 people per car, 90 cars can also carry 360 people. The distance traveled is 500 miles and the amount of fuel varies.

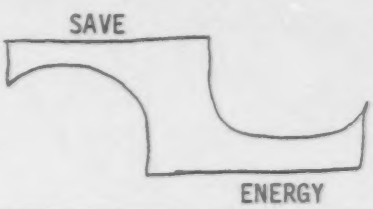
Kind of Transportation	Miles Traveled	No. of Passengers	Gallons of Fuel Used
1 plane	500	360	3,911
90 cars	500	360	3,316
1 train	500	360	1,238

--How much fuel is used by each person when traveling by plane? train? car?
--Which method of transportation conserves the most fuel?
--Which wastes the most fuel?
--Can you figure out how many gallons of fuel would be used if each car carried only 2 passengers?

Card 6 -- Energy Symbols

Design a conservation of energy symbol. Remember to:
a. try to make it simple
b. try to make it eye-catching
c. try to make it self-explanatory

The purpose is to show that energy can be conserved.
For example, Stephen Anderson, a student from the University of Minnesota, designed the symbol below. It is the electrical symbol of the fuse. Since a fuse protects a circuit from overuse of electrical power, it is a good symbol for protection of natural resources.



Card 7 -- Who's the Energy Glutton?

Survey every room in your home, listing carefully on a chart like the one below each item requiring energy (use column A).

In column B, list the source of energy required, such as gas, electricity, oil, battery, coal, solar, etc.

In column C, tell whether the item is essential, a luxury, or questionable.

A Items that Need Energy	B Energy Source	C Really Needed? Why?
For example: Refrigerator	Electricity	Yes - To keep food from spoiling

Card #8 Energy Inventions

Make a list of 10 inventions over the past 200-250 years and identify the kinds of energy each invention requires to operate. Do any listed require no energy?

-which inventions require the greatest amount of energy?
-what environmental impact did the inventions have?

Card #9

There are about 100,000,000 motor vehicles in the United States. Most of the vehicles are for personal use. Pretend you are going to write a law which would restrict the use of personal autos to reduce air pollution and energy consumption.

-what would you say in your law?
-what kinds of arguments would you expect from the opponents of the law? (Who would the opponents be?)

Card #10

Today in Europe there are many ancient statues and buildings that are in danger of being dissolved or permanently disfigured, not by vandals but by something else.
SOLVE THIS MYSTERY!

-who or what is causing the destruction?
-how can it be stopped?
-should we worry about this problem? Why?

Card 11 Solar Cars?

The Astronauts use solar-energy as a primary energy source when on the moon. The energy is provided by a conversion of the sun's solar energy to electric energy. This source has been suggested as an energy substitute for gasoline to provide power to autos. List and describe some of the problems which might take place if autos were made to use solar energy. How might they be solved?

Design your own "solar car" and make a drawing or a model of it. How does it work?

Card #12 Designing a Miniature Power Plant

Materials You Will Need:

Rubber bands
Wooden Thread spool
2 wooden matches (or pieces of plastic straw)
1 ½ inch thick wax washer (cut from a candle)
1 small nail

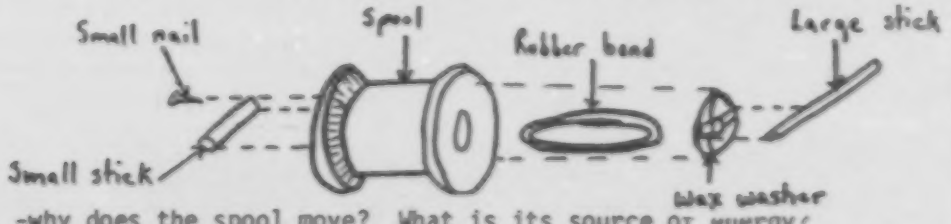
Directions to construct this power plant are as follows:

1. Drive the nail into the spool, about 1/8 inch from the hole.

2. Cut a ½-inch round slab of wax. The end of a candle can be used for this. Bore a hole in the center and notch one side.

3. Thread the rubber band through the wax washer and the hole in the spool; loop it over the large stick at the end with the wax washer and over the small stick at the end with the nail.

4. Wind the large stick about 10 to 20 turns, place on a flat surface, and release. The spool should move forward at a slow even rate.



-why does the spool move? What is its source of energy?
-what could you do to increase the rate of speed of the spool?
-can you determine the rate of speed of the spool in inches/min? centermeters/min?

AIR POLLUTION ACTIVITIES

Air Pollution Activities:

Introduction:

"Air pollution is a serious problem confronting urban areas. Some scientists predict that by 1980 urban dwellers will be forced to wear gas masks to survive air pollution. By the early 1980's, it is predicted that air pollution, trapped by temperature inversion, will kill thousands of Americans in some U.S. city. As early as 1985, air pollution could be severe enough to cut by ½ the sunlight now reaching the earth. While all scientists do not agree with these "Doomsday" predictions, they agree that air pollution poses certain immediate problems which need to be resolved.

Air pollution can be a killer. On a windy day, the air can rid itself of great amounts of pollutants by absorbing soot and smoke and blowing it out of the area. But during a temperature inversion, smoke, soot, and chemicals are not blown away and the air hangs over a region. Deaths due to air pollution have occurred in Belgium, Pennsylvania, and London, killing hundreds of people.

Air pollution also poses indirect hazards to our health. Smog cuts visibility, often resulting in traffic delays and accidents. Plants are harmed by air pollution, resulting in agricultural problems. Public statues and monuments are slowly deteriorating due to air pollution.

In short, not only is air pollution dangerous to our health and costly to a thousand obvious and hidden ways, but the pollutants themselves represent wastes of our resources as well. If such wastes could be recaptured or reused efficiently we would have cleaner air while conserving needed natural resources.

Air pollution is of two general types -- natural and man-made. Natural pollution consists of substances such as pollen, fungi, and dust which cause allergic reactions in a large portion of the population. Man-made pollution can result from both industrial and personal use of polluting substances. Combustion, such as for industrial heat and power as well as industrial processes often result in air pollution. Individual home heating furnaces, motor vehicles, and solid waste disposal contribute significantly to air pollution problems."

(Adapted from: "Investigations in Environmental Science," Fairfax County Public Schools, Fairfax, Virginia.)

AIR POLLUTION ACTIVITIES

Teaching the Activities:

The experiments in this section are varied. Some are designed to show that there is air pollution and that it affects everyday objects and organisms. Some show methods of identifying pollutants and their sources. Others show some of the methods currently used in abatement of air pollution.

Included in the kit is the book Air Pollution which contains several basic experiments that help explain the basic principles of air pollution as well as containing background information. You may wish to choose some of the experiments in this book for individual students to perform.

You will need to examine the activities which follow and decide on those that are interesting and appropriate for your students.

* Indicates included in kit.

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Air Pollution Activities: REFERENCES AND RESOURCES

Books:

Aylesworth, T.G. This Vital Air, This Vital Water. Rand McNally, 1968.

Battan, Louis J. The Unclean Sky. Doubleday and Co

* Blaustein, Elliott. Anti-Pollution Lab. Sentinel Books Publisher, Inc., 17-21 East 22nd Street, New York, NY 10010

Eblen, William. Air Pollution: The World's Exhaust. Pendulum Press, 06516

Leinwand, Ed. Air and Water Pollution. Washington Square Press, 1969.

Activity Guides:

* "Eduquip Air Pollution Study Program Manual"
Available from: Eduquip Inc.
1220 Adams Street
Boston, Mass. 02124

"Air Pollution Experiments for Junior and Senior High School Service Classes"
Available from: Air Pollution Control Association
4400 Fifth Avenue
Pittsburgh, PA 15213 @1.50

"Scientific Experiments in Environmental Pollution"
Holt, Rinehart, and Winston

"Testing for Air Pollution, Science Study Aid No. 5"
Available from: U.S. Department of Agriculture

Pamphlets:

* "Needed: Clean Air"
Available from: Environmental Protection Agency
Washington, D.C.

Air Pollution Primer:
Available free from: Potomac Tuberculosis and Respiratory Disease Association
Post Office Box 277
Fairfax, Virginia

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"Air Pollution" a reprint from Ranger Rick National Wildlife Federation, 1412 16th Street, NW, Washington, D.C. 20036

"A Citizen's Guide to Clean Air" Free from The Conservation Foundation, 1717 Massachusetts Avenue, NW, Washington, D.C. 20036

"Citizen for Clean Air" Fact Sheet, 502 Park Avenue, NY, NY 10022

"A Primer on Air Pollution"
Available from: Mobil Oil Corporation
150 East 42nd Street
New York, NY 10017

"Clean Air for Your Community" (0-386-123)
Available from: U.S. Government Printing Office
Washington, D.C. 20402

"Air Pollution Episodes: A Citizen Handbook"
Available from: U.S. Environmental Protection Agency
Washington, D.C. 20460

Newsletters:

Air Pollution Notes
Available from: College of Agriculture and Environmental Science
Rutgers University
New Brunswick, NJ 08903 (FREE)

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WHAT DOES AIR POLLUTION LOOK LIKE?

Concept: Air pollution can be found in any environment.

Activity: Sampling particles in the air.

Teaching Suggestions:

When collecting airborne particles, two types may be collected --those that settle to the ground and those that are light enough to be blown continuously by the wind. You may wish to have students determine if there is a difference in these particles by having the students place one collecting sample in a verticle position and one in a horizontal position.

There are two methods suggested for doing this activity. Choose the most suitable for your students.

In this activity, students collect samples of air pollution particles by placing vaseline-coated collectors outside and then examining them.

Method I:

Materials Needed for Each Student or Team of Students:

- Waxed paper pieces 6 cm square (1 piece per sampling site)
- White paper pieces 6 cm square
- Metric ruler
- Boards with thumbtacks
- Petroleum jelly
- Hand lens

Procedure for Method I:

1. Use the ruler and a pencil to mark the waxed paper pieces into 1 cm squares.

2. Place the waxed paper on top of white paper and tack both pieces to a board with thumbtacks.

3. Smear the waxed paper liberally with petroleum jelly.

4. Set the board in the open for about a week; choose a location where the board will remain undisturbed. For comparison, place the boards in areas where different types of particulate pollutants can be expected, such as at a construction site, on the school roof, indoors in the classroom, near a factory or incinerator, beside a busy highway.

5. After a week, retrieve the sample. Take the waxed paper off the boards and transport it like a cylinder -- jelly-side in, in a jar or paper cup.

Method II:

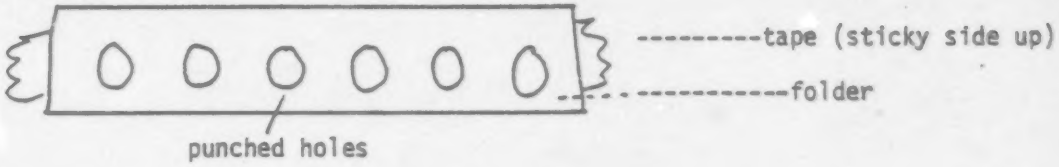
Materials Needed for Each Student or Team of Students:

Manilla folder, cut into 1-inch strips
Transparent tape
Hole punch

Procedure for Method II:

1. Have students punch holes in a strip of manilla folder.

2. Place a piece of transparent tape on the strip so that the holes are covered:



3. Students can then proceed as in Method I above to place their collectors in appropriate locations. The particles should settle on the sticky circles. Additionally, the strips can be examined under the microscope.

Analyzing the Data and Drawing Conclusions:

Have the students examine the particles on the waxed paper with a hand lens. Choose a square and count how many different types of materials can be seen. You may wish to compare the class results on a chart and try to draw conclusions about the amount of particulate matter in the air in the different sampling sites.

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Questions for Class Discussion:

-Which of the following materials did you find? Dust, pollen, ash spores, soil, hair, etc.

-Which did you find the most of?

-Did other students have the same amount of each type of materials?

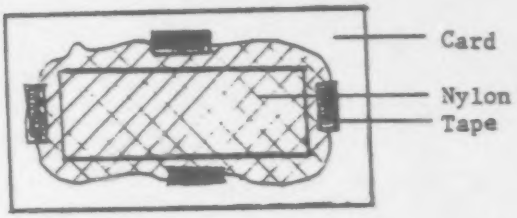
-What was the most common type of material present?

-What types may have come from industry?

-What does the number of particles in a particular square indicate about the amount of air pollution in that location?

Extending the Concept How does air pollution effect fabric? Students can investigate this question by using the procedure suggested below:

Students can obtain 3 x 5 file cards or photographer's slide mounts and test the effects of air pollution on these samples. Cut a square hole in the file card and attach the sample to be tested:



The same procedure can be used with the photographic slide mount. Microscopic examination should reveal broken threads or other signs of deterioration. Leave samples at least 30 days. Students may wish to place control samples indoors.

Adapted from: "Pollution Studies," Science and Children, 10:6, p. 27-32, March, 1973.

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AIR POLLUTION AND THE INTERNAL COMBUSTION ENGINE

This experiment provides a method of comparing the relative amounts of particulate pollutants produced by different internal combustion engines. You may wish to compare different makes or models of automobiles, the family cars of your students, or the teachers' cars in the school parking lot. It might also be fun to test different types of internal combustion engines, such as lawn mowers, motorcycles or go-carts.

Materials Needed for Each Student or Team of Students:

- Paper cup
- Petroleum jelly
- Waxed paper pieces 6 cm square (1 per engine)
- White paper pieces 6 cm square
- Cardboard-thumbtacks
- Hand lens
- Metric ruler
- Watch with a second hand
- Plastic wrap

Procedure for Students:

1. Cover a piece of waxed paper with a thin coat of petroleum jelly, place it on top of a piece of white paper, and tack both to a piece of cardbord with thumbtacks.

2. After obtaining the owner's permission for the test and asking him to start the engine, hold the cardboard sampler about 15 cm from the mouth of the exhaust for 2 minutes.

   NOTE: (SAFETY PRECAUTIONS): Do not touch the exhaust pipe -- it's hot; and keep your face away from the exhaust.

   Label the sample as to engine type, year, number of cylinders and type of fuel burned. Write down car make, model, year, and type of fuel.

3. To transport the samples back to the classroom, remove the waxed paper from the cardboard (being careful not to smear the sample) and then place the wax paper in a paper cup curled like a cylinder with the petroleum jelly facing in.

4. In the classroom, use a hand lens to examine the particulate pollutants and then record your observations as to number, color, size, texture, etc.

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Analyzing the Data and Drawing Conclusions:

You may wish to have the students mount the samples on posters in order of the exhaust with the most particulate matter to the least, so that the class can compare results.

-Which cars had the largest amount of particulate matter?
-Did these cars have anything in common? (Age, model, etc.)
-Are there any relationships that you can draw, such as the amount of particulate matter and the type of fuel?
-How is testing of automobile exhaust actually done?

Adapted from: "Pollution Studies," Science and Children, 10:6, p. 27-32, March, 1973.

WHAT HAPPENS WHEN GARBAGE IS BURNED?

Concept: Burning causes pollutants to be added to the air.

Activity: Different types of garbage is burned and comparisons made.

Special Note: This activity is adapted from the booklet Pollution, pp. 18-20, which is included in the kit. It is suggested that you read this before beginning the activity.

Materials Needed for Each Student or Group of Students:

Materials to burn: cardboard, paper (different kinds)
glass
aluminum foil
plastic wrap
plastic spoon
wood
cloth
nylon
egg shells
etc.

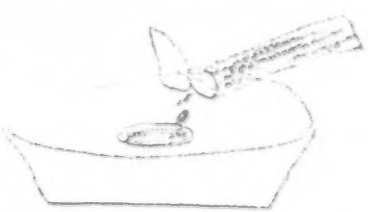
CAUTION: This activity uses fire. Have a fire extinguisher in the classroom.

*1 small aluminum pie pan
*1 large aluminum pie pan
*1 spring clothes pin
*1 candle
*matches

Preparation for Activity:

1. Have students gather small pieces of mateirals for burning. Break or cut a small piece from each material so that each sample is approximately the same size.

2. Make "burners" for the students (or have older students do it themselves) in the following way: Melt wax from the candle onto the center of the larger aluminum pan to create a base for the candle. Set the candle in the wax:



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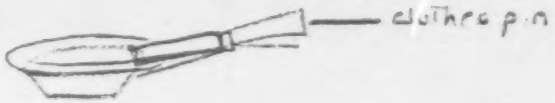
The completed burner should look like:

3. Attach spring clothes pin to small aluminum pie plate to serve as a handle to the burning pan:



4. Have students make a chart like the one below to record the results of their experiment. (An example is show on p. 19 of Pollution.)

Type of Material	Time to Burn: Start	Time to Burn: End	Description of smoke	Description of ash	Odor	Changes from original
1.						
2.						
3.						

Teaching Suggestions:

1. Have students heat the small pie pan containing the different types of materials and record the results on their chart.

2. Ask students to examine the results of the chart and make some conclusions about the different items. Students might want to look at their classmates' charts for comparison.

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Questions for Discussion:

1. Which type of material produced the most smoke?
2. Which produced the most unpleasant odors?
3. Which materials took the longest to burn? The shortest?
4. Which materials left behind the most ash?
5. Which materials do you think contribute the most to air pollution? Why?
6. Which materials were not changed by burning? How might you dispose of these materials?
7. Have you ever seen materials being burned and causing air pollution? (The N.J. Turnpike!) What is it like? What might we do about it?

Extending the Concept: How is an incinerator used to burn garbage?

-What kinds of pollution are cuased by incineration?
-How are some incinerators constructed to help control air pollution?
-What are some of the local laws regarding incineration?

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THIS IS AN ADVANCED TOPIC.

DEMONSTRATION OF A TEMPERATURE INVERSION

Concept: A temperature inversion can take place when an exceptionally stable layer of cold air is trapped.

Activity: An activity which demonstrates the principle of a temperature inversion.

Background Information for the Teacher:

Ventilation is nature's way of diluting an atmosphere in an effort to reach an equilibrium. When ventilation of an area is prevented for any reason, an unnatural build-up of pollutants occurs even if the generation rate of pollutants remains constant. This statement is true not only in the outside atmosphere but in any environment.

For example, when the windows and doors to a room are opened the build-up of pollutants is not appreciable due to natural ventilation. However, when the portals are closed, and pollutant level can rapidly build to an intolerable level if people are smoking or food is being prepared.

The atmosphere in which we live is similar to this room. It must be constantly ventilated to prevent build-up of high concentrations of pollutants which are generated by both natural phenomena as well as man. Warm air tends to rise and if the temperature of the air at ground level is higher than the temperature above there will be a constant flow of air from the ground upwards. This is nature's way of continuously venting the ground environment.

However, when the temperature of the air at the ground becomes lower than the temperature of the upper atmosphere this ventilation process if drastically reduced and the pollutants which are generated into the atmosphere are not swept away. This results in a temperature inversion. Therefore, the concentration of pollutants in the entire air volume under the temperature inversion increases, giving way to creation of photochemical smog among other things.

How a Temperature Inversion is Created:

During the day the radiant energy of the sun warms the earth, which in turn warms the adjacent layer of air. This warmer air being less dense than the air above, rises through the cooler air and is blown away and dispersed by the wind in the upper atmosphere. After sundown the earth's surface cools quickly and in turn cools the layer of air adjacent to the earth. Because of the difference in

elevation, the surface air near the top of the hill is colder than the surface air near the bottom of the hill. Because a given volume of air becomes heavier as the temperature drops, the cold air near the top of the hill actually flows down the hillside and collects at the bottom under the layer of warmer air directly above it.

If the bottom of the hill is in a valley, this cold air will be flowing down both sides of the valley and will gradually cool the smoke and polluting gasses so that they cannot rise through the overlaying warmer air. The result is that the pollutants continue to collect and become more concentrated in the space where people live near the ground.

The next morning, the rising sun gradually warms the layer of polluted air adjacent to it. This warm layer of air rises and eventually warms the entire polluted layer until it is able to rise through the warm layer which has been holding it down. A complete overturn of the air, which is called the break-up of the inversion, then occurs.

If, some some reason, the ground does not warm up fast enough, or the upper level does not cool fast enough, the inversion continues, thereby dramatically increasing the pollution level. The concentration of pollutants will continue to build until some meteorological phenomenon such as rain, snow or wind occurs to break it and disperse the pollutants.

Materials Needed for the Demonstration:

Eduquip Temperature Inversion Apparatus
- tube
- base
- rubber squeeze bulb with tubing
- 2 thermometers

String
Tape
Cigarette & match
Ice

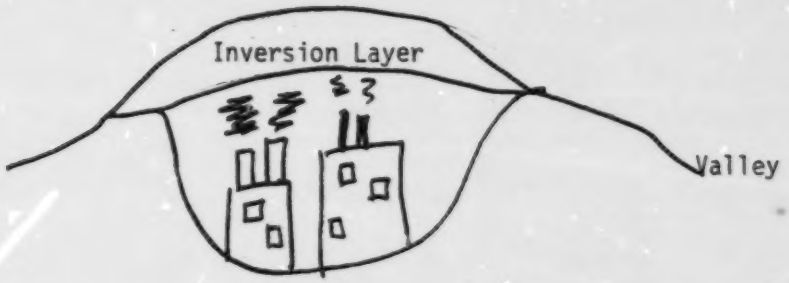
Teaching Suggestions:

1. You may wish to reach and discuss the following with your students:

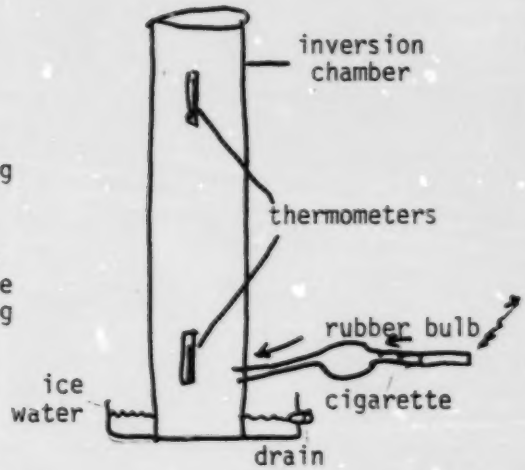
   "On October 26, 1948, citizens of Donora, Pennsylvania, awoke to a dark, ominous morning. The various industries and businesses of the town were emitting their usual contaminants into the air. On any ordinary day, warm, light air rising from the ground surface carried such pollutants into the cooler atmosphere above. Here they were diluted and dispersed by prevailing winds. However, on this particular day, a blanket of warm air had formed above the cooler air mass enveloping the town. During the day, warm surface air and vapors produced by industries steadily cooled while rising. When this air reached the upper limits of the cold air mass, it was no longer lighter than the warmer air mass above. Unable to rise further, the contaminated air was trapped between the upper and lower air masses.

Within 48 hours, visibility was drastically reduced. Donora medical authorities were swamped with people suffering from a range of ailments: stinging eyes, throat irritation, nausea, breathing difficulties, nasal congestion, and coughing. During the four long days that the deadly shroud hung over Donora, almost 50% of the 12,300 citizens suffered illness. Before a heavy rain eventually cleared the air, death claimed 20 people and numerous animals such as cats, dogs, and birds." (from Environmental Pollution, p. 135.)

2. A thermal inversion may be a difficult concept for students to understand. You may want to draw a diagram like the one below and discuss it with students:



Procedure:



1. Set up the apparatus as show in the diagram. A convenient method of hanging the thermometers is to tie pieces of string to the thermometers and then secure the opposite ends of the strings to the top of the inversion chamber tube using tape. One thermometer should hang a few inches above the bottom of the chamber and the other about 3 inches from the top.

2. Fill the plastic trough with ice water and wait until the temperature at the bottom of the chamber ("ground level") is at least 3^{o} C less than the temperature at the top of the chamber.

3. Insert a cigarette into the plastic holder (tape may help to secure it) and light the cigarette with a match while gently squeezing the rubber bulb.

4. Very gently introduce smoke into the chamber by squeezing the bulb slowly and steadily. When the smoke has stabilized about 6 inches from the top of the inversion chamber, remove the smoke generator tube and plug the hole through which it was inserted using a piece of tape.

Discussing the Demonstration With Your Students:

1. A temperature inversion has now been created simulating sunset when the cooler air is at the bottom of the valley. How long will the inversion last? (Until the temperatures at the top and bottom are the same and the smoke diffuses out of the chamber.) Some students may wish to test this.

2. What is the minimum temperature difference necessary to maintain a stable layer of smoke in the chamber? (Some students may wish to test their predictions.)

3. Does the extent of the temperature difference between the upper and the lower regions of the chamber greatly affect the dispersion of the smoke? (No. A difference of a few degrees is necessary to set up the inversion, but beyond that any further difference is of little consequence.)

4. How is a real temperature inversion reversed and normal conditions restored? (The rising sun warms the ground which, in turn, warms the air next to it. When the temperature of the lower air mass reaches and exceeds that of the upper mass, the smoke rises and the inversion breaks up. Ventilation by wind and the washing out of pollutants by rain or snow also help to return the situation to normal.)

5. You can simulate the return to normal conditions using the inversion chamber. Remove the ice water by opening up the drain hole at the bottom of the trough and removing the ice cubs. What natural situation is being simulated by the removal of the ice water? (Sunrise) The "ground level" temperature will now increase and eventually the smoke will begin to rise up the column. To speed this process, replace the plug in the drain hole and pour hot water into the trough. At what temperature does the smoke start to rise? (When it exceeds the temperature of the upper atmosphere.)

Adapted from Eduquip Air Pollution Manual, David Gordon, ed

Extending the Concept: Research Questions

1. Are temperature inversions common in your area at any time of the year?

2. What exactly happened in Donora, Pennsylvania?

(15)

CONTROLLING GASES AND ODORS WITH ACTIVATED CHARCOAL

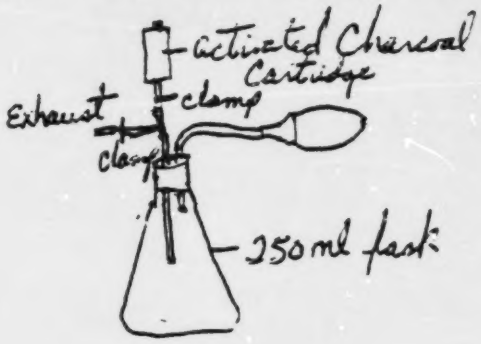
SOME forms of air pollution are caused by industrial gases and vapors. Many of these pollutants produce strong or noxious odors while others may adversely affect our health by causing lung damage or other bodily harm.

The precise methods of removing these pollutants from the air are as varied as the contaminants themselves, but generally utilize four different mechanisms: (a) absorption of the pollutant into a liquid in a spray tower, (b) absorption of the pollutant onto an active surface such as activated charcoal or silica gel, (c) condensation of the pollutant into the liquid or solid phase by cooling, and (d) burning the pollutant, sometimes with the aid of a catalyst. But because the pollutants and industrial situations are so varied, each air pollution problem is treated as a custom chemical engineering problem.

This activity shows the students that it is possible to remove offensive substances from the air and demonstrates one of the methods used by industry to clean the air--the absorption of pollutants by activated charcoal.

Materials per team of students:

* 1 250 ml flask with 2-hole stopper
* Squeeze bulb
* "T"- connector
* Plastic tubing
* Activated charcoal cartridge
* Pine Sol
* Oil of Wintergreen
  Cigarette or cigar butts, if available



Procedure:

Set up the materials as shown in the diagram. Pour a few drops of Pine Sol and Oil of Wintergreen into the flask and add the cigarette or cigar butts. Close the pinch clamp to the activated charcoal cartridge. Squeeze the bulb gently once or twice while sniffing the exhaust outlet. What does it smell like? Was the odor strong or faint? Now close the clamp at the exhaust outlet and open the clamp to the activated charcoal cartridge. Again squeeze the bulb gently while sniffing the outlet at the top of the cartridge. What does it smell like? How does the odor compare to that of the first trial? How do factories remove odors from their smokestacks? Use your imagination and see if you can design a way to remove air pollutants from a factory smokestack. You might like to draw your system on your worksheet.

Adapted from: Educ-ap Air Pollution Teacher Resource Manual, David Brandt ed.

WHAT CAN I DO ABOUT POLLUTION?

Activities: Ideas for projects students might like to do to help fight pollution in their own community.

The following is a list of projects or activities which students might wish to pursue. Please let CBE know of any projects your students and you become involved in and we can include them in this list.

Projects:

1. Students might start an "anti-pollution" campaign at school, making posters, bulletin board displays, etc.

2. Make a collage from magazine advertisements of products, which because of manufacturing or problems of pollution or disposal, contribute to our environmental problems. Then, make another collage of products which do not.

3. Organize a photography contest in your school or community for the "Dirty Picture of the Week" or month, showing the most flagrant pollution problem.

OUTDOOR ACTIVITIES

UNIT III. OUTDOOR STUDIES

The activities in this section are intended to extend students' concepts of ecological principles to the outdoor environment. These activities can be used to supplement and enrich experiences the students have in the classroom.

It is hoped that you will use outdoor activities as they seem appropriate to you. Several activities are included in this guide. In addition, there are a number of booklets and materials included in the kit from which you can choose suitable experiences. In planning outdoor experiences for your students, you will undoubtedly wish to consult these references. Depending on time available, student interest, available resources, etc., you can plan a program of outdoor experiences for your students.

Preparation for Outdoor Activities:

It is best to study the area you wish students to explore before taking students outside so that you are familiar with the area and know what to expect when you return with your class. You will want to explain to the class the nature of the activity before going outside. Prepare directions and worksheets for the students and discuss these with the class before going out.

It is best to make sure students know what behavior is expected of them. Indicate the boundaries of the area to be studied. Set time limits on all activities.

Outdoor Activities Included in the Guide:

Below is a list of outdoor activities which follow in the guide. Specific instructions are included with each activity.

I. Outdoor Bingo
II. What Can You Find Out About an Organism?
III. Problem Cards for Outdoor Activities
IV. A Study of a Woodlot
V. Life on a Rotting Log
VI. Making a Waterscope

(I-V of the above activities were adapted from Fairfax County Public Schools, Fairfax, Virginia)

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Materials Included in the Kit for Outdoor Study:

1. NEED Sound Filmstrip Package - This set of four filmstrips centers around the idea of people in relation to the outdoors, specifically the National Park system. The set includes:
   Filmstrip 1: People Parks (National Capital Parks)
   Filmstrip 2: The National Park Study
   Filmstrip 3: Leisure: The Environmental Impact
   Filmstrip 4: Life-Styles: The Environmental Impact

   The booklet accompanying the filmstrips contains specific suggestions for lessons centering around the filmstrip.

2. OBIS Activities: Set I, II, and III - "Outdoor Billogy Instructional Strategies (OBIS) offers both independent and sequential activities to promote the understanding of ecological relationships by youngsters from ten to fifteen years of age. The major goal of OBIS is to design instructional strategies for learning experiences in outdoor biology that can be applied in diverse environment. . .The activities introduce basic concepts of ecology in interest-cathing ways. Youngsters investigate the interrelationships and interactions of plants, animals, and the physical environment, including man's role in the natural scheme. Such first-hand experience forms the basis for the understanding of basic biological relationships. This understanding is necessary to develop the public consciousness required to support appropriate management of man's environment."

   Each OBIS package contains a wide variety of exciting outdoor experiences for students. Look through the packets and choose those that might be interesting to you and your students.

3. Resource Guide - Several resource books are included which contain ideas you may wish to use with your students.

   A. Mini-Climates is a book students themselves can use to investigate the idea of limiting factors in an environment, including temperature, light, moisture, wind, and soil. This book would serve as an excellent guide book and resource for some of your more interested students who might wish to pursue some of these studies in depth.

   B. Transect Studies, Stream Profiles, and Outdoor Fun for Students are excellent references containing many activities and experiences for students in the outdoors. These teachers' guides are clearly written and easily implemented. Each booklet contains data sheets and other worksheets that can be reproduced for students.

   C. NEED Outdoor Books - These outdoor study guides are included in the kit. These booklets are written for students and can be used for independent study and investigation by any of your students. The books are each aimed at students of different reading abilities.

   D. All Around You is a teacher and student environmental study guide written by the U.S. Department of the Interior. It includes activities on environmental awareness, the urban ecosystem, and nature's ecosystem.

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Outdoor Bingo

This game can be used on a field trip, right outside the classroom, or in any outdoor situation to aquaint students with the variety of life outdoors. Students can play individually or in teams of 2-4. The game can be restructured to any outdoor situation by simply changing the items on the sheet.

Materials Needed

1. A bingo type board or duplicated sheet for each player. The board should contain the names of organisms that are to be found by players. The board should be designed as follows:

Difficult				Difficult
	Difficult		Difficult	
		Rare		
	Difficult		Difficult	
Difficult				Difficult

(A sample board follows)

2. Each player will need a pencil or pen.

3. Each team will need a container such as a plastic bag to place their collected specimens in.

Procedure

1. The teacher must survey a specific geographic area before the game is played in order to see what specimens are available; then the playing board can be made.

2. Teams of 2-4 should be chosen and each player should receive a copy of the board.

3. Students should be instructed on how to play the game: they are to find as many of the organisms listed on the sheet. As in Bingo, each box covered will win a certain number of points.

Make sure students understand that they must stay within the area the teacher designates - anyone leaving the area should be disqualified.

Scoring:
2 pts - each block covered
10 pts - each horizontal line
15 pts - four corners
20 pts - each vertical line
50 pts - each diagonal line
50 pts - center square
365 pts - total for all squares covered

4. After a time period specified by the teacher, teams return to the classroom and match specimens to the board examples and the score is calculated. Some items may be difficult to bring inside, or too valuable to pick. In this case, the teacher should initial the student's sheet when the item is found.

Follow-up Discussion Discuss the activity with the students. Ask them what they learned from it. What interesting items did they find? Ask them how they liked going outside. Did they notice things they never noticed before? What observations would they like to share with the rest of the class?

1. Ask the winning team why they think they won. (i.e., did they know a lot about the outdoors?)
2. How difficult is it to find organisms outdoors? Why? Are some organisms more difficult than others? What might cause this?
3. Ask questions regarding the recognition of specimens. For example, how did you know this was a fern?
4. Ask questions about habitat - Where did you find the fern? What was it near? Was the area dry or moist?
5. Have interested students make up their own playing board.

An example of an Outdoor Bingo Board:

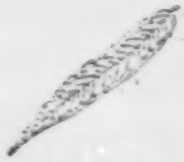
daddy long legs	daisy	sassafras leaf	red and yellow leaf	land snail
clover	maple leaf	6 blades of grassa	beetle	cricket
acorn	fern	orange mushroom	moss	isopod
oak leaf	white mushroom	holly leaf	pine cone	black rock
black-eyed Susan	dandelion	red ant	bird feather	lichen

Designing the Board

You should be able to design the board to meet the needs and interests of your students. For students unfamiliar with the outdoors, it would be good to include pictures in the squares. More sophisticated students could be given a board with difficult items such as algae, monocot, etc.

The board could also be designed as an activity to help students learn the names of various trees, flowers, insects, plants, etc. For example:

Tree Identification Bingo

Hemlock	Pine	Beech
White Oak	 Willow	Sugar Maple
Hickory	Sassafras	Tulip

Activity ___: What Can You Find Out About An Organism?

This activity could be done indoors if the weather is unfavorable for outdoor activity. However, you would have to collect at least 25 specimens for the class to study. The activity is more successful when students find and choose their own organisms to study.

Teaching Materials

For each student:
paper
pencil

> Allow students at least 10 minutes to find an interesting organism to study.

Procedure

1. Take the class outside to an area where they are sure to see living organisms. An ideal spot would be a dense forest with a stream running through it, although any outdoor area can be used.
2. Students should find one organism they would like to find out more about. They should look at it for 10-20 minutes, drawing it and describing it in the best way they can. The question they should direct their attention to is:

> What did you find out about this organism that you did not know before?

   The organism can be plant or animal.
3. Students should share their observations with other members of the class. Have students sit in a large circle (either outdoors or indoors) and share with the rest of the class what they have found out.
4. Any student who wishes to bring his specimens inside should be encouraged to do so, provided he accepts the responsibility for caring for it. He should do research on how to keep it alive.
5. Some possible organisms for study are:

insects	ferns
crayfish	water beetles
snakes	fish
land snails	frogs
slugs	toads
salamanders	mushrooms, fungi
newts	lichen
buds	liverwort
shrubs	saplings
weeds, flowers	galls
cocoons	etc.

6. Students should be encouraged to find out more about the organism they studied by referring to the reference books in the class libra

Activity ~~Ten~~: Problem Cards for Outdoor Activities

These cards are intended to increase the student's awareness of his outdoor environment. They encourage observation and critical thinking.

Look through all the cards and decide which are interesting and relevant to your class. Most cards have an activity which will take the students 15-20 minutes to complete.

You might wish to allow each student to choose a card that is particularly interesting to him. Have the students go outside and seek answers to the questions posed on the cards. They should record their responses in some informal way - it is not advised that they be required to write a detailed answer down while they are outside.

When students have finished or during the next class period, have students gather in a circle and share their experiences and perceptions with the rest of the class. Students who did similar cards might make a joint presentation. It is best not to require students to hand in the results of the activities since writing is difficult and time consuming for students to do in the field.

Students should be encouraged to explore several problem cards if they finish before other class members.

Problem Cards for Outdoor Activities

Find something outside that is increasing in number and something that is decreasing in number AND THEN PROVE IT!

Go outside and count something so you know more about it after you have counted it than you did before you counted it.

Go outside and find the youngest and oldest thing you can see. What are they? What makes you think they are the youngest and oldest?

Using any of the items below that are available, discover as much as you can about some area you find outdoors. Record what you find out so that you can share it with the rest of the class. You might want to use:

- -string
- -sticks
- -paper
- -ruler
- -measuring tape
- -camera
- -anything else you can think of

Collect the largest and smallest leaves you can find. Do you know what kind they are? Why do you think some trees have large leaves and others have small leaves?

Walk through a field with high grass for 5 or 10 minutes. Are there any small objects attached to your clothing? Separate them into groups and draw a picture of each different group. How many of each kind did you find? What do you think these things are? Why?

Go outside and look around carefully. See if you can find a million of something. Then prove it!

Go outside and find a comfortable place in the woods. Write a description or make a drawing of the area around you.

--Describe the way you think it looked 25 years ago.

--Describe how you think the area might look 25 years from now.

How many items can you find that smell sweet? sour? good? bad? Describe or draw them by making a chart like the one below and bring the objects inside if possible to share with the rest of the class:

sweet	sour	good	bad

The Rock Game

Make a collection outside of 10 rocks that look different. What is it about each rock that makes it "different"? Describe or draw the rocks in some way, so that if another student in the class picked up your ten rocks, he would know which drawing or description fit which rock. Now try it with a classmate!

How good were your descriptions? How could you improve them?

If you have a tape recorder, go outside and record at least 5 different natural sounds. Try to identify them if you can. Play them for two of your friends and see if they can guess what they are. How did they do?

Lie on the ground, face down. Make a circle by stretching your arms out in front of you on the ground. What kinds of plants are inside that circle you made with your arms?

--What animals can you find crawling through the grass?

--What else do you see?

Go outside and find a tree you would like to study. Do the branches grow straight out from the tree? Do they branch in any special way?

--Do the leaves grow up or down from the branch?

--Do the leaves grow all along the branch or only at the ends?

Activity: A Study of a Woodlot

The following activity was developed from ideas suggested in the following references:

Transect Studies
Soil
Stream Profiles
Outdoor Fun for Students
Vacant Lot Studies

These guides are published by the National Wildlife Federation and The Minnesota Environmental Sciences Foundation. They are excellent references, containing thousands of ideas of activities for students. They will be extremely useful for all outdoor activities. It is suggested that you read through these guides and adapt them to your own students.

The following activity is an example of a woodlot study adapted from the material in Transect Studies.

This activity is especially designed for wooded areas near or on school grounds. Students will need approximately two class periods of outdoor work in order to complete the study. The students should be divided into teams of three students, and identified as team members A, B, and C. Each team member should pay close attention to his specific responsibilities as outlined on the data sheets.

The students should work in quadrat areas approximately 3 meters square. The students themselves can rope this area off or the teacher might set up these areas ahead of time. Each team should have its own quadrat for the two day period.

Follow-up Discussion

When the students have finished the outdoor exercises, they should return to the classroom and spend approximately one class period sharing data with their team members.

Studying the great quantity of data collected can be a frustrating experience. One of the best discussions of how to pull all this information together can be found in the booklet Transect Studies, pp. 14-20. Read this before beginning a discussion of these outdoor activities with your students.

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Name: [redacted]

A Woodlot Study

You are going to look carefully at a wooded area. Make careful observations and measurements so that you can share these later with your team members. Study only the things in your own roped in area. Have fun!

Your Team Members: A.

B.

C.

Team Member A: General Characteristics of the Woodlot

1. Weather: Put a check in the boxes which apply to the weather today.

very sunny (no clouds)	☐	hot	☐
partly cloudy	☐	warm	☐
very cloudy	☐	cool	☐
dark sky	☐	chilly	☐
rain or mist	☐	cold	☐
fog	☐	windy	☐

2. Sunlight Information: look up and see if there are any trees that block the sun from reaching every point in your plot. Answer the questions below:

		check one		
1.	What time of day is it?	☐ morning	☐ noon	☐ afternoon
2.	Does most of your lot receive full sunlight?		☐ yes	☐ no
3.	Check one of the following that best describes the amount of light entering your plot.		☐ shady ☐ dark ☐ no sunlight	

3. Temperatures
   A. Air Temperature _____ °C
   B. Soil Temperature _____ °C

4. General Appearance: put a check in the boxes which describe the general appearance of the woodlot:

		Yes	No
a.	plant life is green and healthy	a. ☐	☐
b.	many rocks	b. ☐	☐
c.	some fallen trees	c. ☐	☐
d.	many leaves on ground	d. ☐	☐
e.	many weeds	e. ☐	☐
f.	many trees	f. ☐	☐
g.	many flowers	g. ☐	☐
h.	candy wrappers or other trash present	h. ☐	☐

What else do you notice about the appearance?

5. Soil Characteristics
   A. Soil Moisture Pick up some soil in your hand and feel it carefully. Check one of the boxes below that best describes the moisture of your soil sample:

- ☐ dry - falls apart and feels very dry
- ☐ slightly moist - appears moist but does not stick together when squeezed.
- ☐ moist - sticks together when squeezed
- ☐ very moist - squeeze and water comes out
- ☐ wet - water drips

B. Soil Color

1. Describe the color of the soil in your plot on the surface.

2. Dig down about six inches and describe the color of the soil.

C. Soil Sample

Scrape away the surface plants in a small area and collect about 20 spoonfuls of soil from the surface. Put it in a plastic bag. Close it up and bring it inside.

1. Did you see anything moving in the soil? Describe it.

2. Were there any plants or animals buried in the soil? Describe them.

D. Making a Map of Your Plot

Draw a map of your plot. Imagine that you are in a helicopter looking down on your plot from above. Indicate where things are located in your plot by using some of the symbols below to indicate the different areas:

tree		rocks		ferns	
shrub		logs		moss	
weed		flowers		water	
grass		mushrooms			

Make up any other symbols you need to and explain them on a separate sheet of paper.

Draw your map on a piece of unlined paper.

Team Member B: What Plants are in the Plot?

Before you can accurately describe the plants in your plot, you must be able to recognize them. The following may help you:

Tree

A tree has a single thick trunk for several feet before branching.

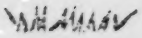
Shrub

A shrub is not a small tree. It has no single trunk, but usually has many branches starting at or near the ground.

Weed

A weed is a non-woody green plant with a stem that bends. It is usually no taller than waist level.

Grass



Grass is usually green and may be as tall as knee level.

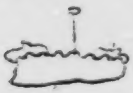
Fungi

ground mushroom

tree fungus

There are two common fungi in the woods, mushrooms that grow on the ground and tree of shelf fungus.

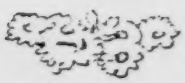
Moss



one example

Mosses are small, green, non-flowering plants. They often look like a soft carpet. They can grow on the ground and on trees.

Lichens



Lichens grow on rocks, trees, and rotting logs. They have no leaves, no stems, or roots. They usually look crusty, sometimes like green "corn flakes".

Look carefully at all the plants in your plot. Then answer the questions below by putting a check (✓) in the appropriate box.

1. Trees

A. Number
- ☐ none
- ☐ 10 or less
- ☐ 10 to 50
- ☐ 50 or more

B. Height
- ☐ mostly small
- ☐ mostly tall

C. Kind
- ☐ mostly evergreen
- ☐ mostly deciduous (leaves fall off in fall)
- ☐ mixture of evergreen and deciduous

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D. Proximity

- ☐ trees are all touching
- ☐ trees close but not touching
- ☐ trees scattered all over

2. Shrubs

A. Number

- ☐ none
- ☐ 10 or less
- ☐ 10 to 50
- ☐ 50 or more

B. Kind

Draw a picture of what one shrub in your plot looks like:

3. Weeds

A. Number

- ☐ none
- ☐ 10 or less
- ☐ 10 to 50
- ☐ 50 or more

B. Height

- ☐ mostly tall
- ☐ mostly short

4. Grass

- ☐ none
- ☐ some grass
- ☐ plot covered with grass

5. Fungus

A. Number

- ☐ none
- ☐ 10 or less
- ☐ 10 to 50
- ☐ 50 or more

B. Kind

- ☐ mostly mushrooms
- ☐ mostly tree fungus
- ☐ mixture of mushrooms and tree fungus

C. Color

- ☐ white
- ☐ orange
- ☐ yellow
- ☐ brown
- ☐ mixed colors
- ☐ other _____

6. Moss
- ☐ plot covered with moss
- ☐ some moss
- ☐ no moss

7. Lichen
- ☐ plot covered with lichen
- ☐ some lichen
- ☐ no lichen

Team Member C: What Animals are There in Your Plot?

You will try to find out about all the animals in the area. You should look for them very carefully. You will need a plastic bag and a spoon.

1. Floor Cover Look down at the leaves and things that cover the soil. Examine them carefully. Put a check in the box of anything you see in the ground cover:

☐ twigs	☐ mold	☐ leaves	☐ worms
☐ moss	☐ lichen	☐ mushrooms	☐ insects

2. Birds

A. Look up in the trees. Do you see any birds? What kind?

B. Do you hear any birds you can't see?

3. Ground Examine the ground of your plot carefully. Put a check in the boxes if you see any of the following:

animal tracks	☐	animal droppings	☐
animal bones	☐	squirrel nests	☐
animal skins	☐	birds nests	☐
holes	☐	burrows	☐

If you checked any of the boxes above, write a short description of what you saw.

4. Insects Capture at least one insect and put it in your plastic bag. Study it carefully and make a drawing of it below:

Name:

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Life on a Rotting Log

Take a good look at a rotting log. Examine it carefully, turning it over and sideways. Answer the questions below based on your observations.

1. Describe the bark on the log. Is it loose?

2. Is the wood hard or soft? _____ Is the wood wet or dry? _____

3. What color is the wood? What does it smell like?

   What color is the surrounding earth?

4. Rake through the rotten wood with a stick. What animals do you see?

5. Are there insects on the bark? Under the bark?
   What kind do you think they are?

6. Are there tunnels under the bark? What do you think made them?

   What do you find in the tunnels?

7. Is there any evidence (feathers, fur, droppings, etc.) that animals have used this log recently? What kind of evidence?

8. Are there any green plants or fungi growing on the log? What kinds?

9. Do you find any animals near the log but not on it? What kind?

10. Why do you think animals live on the log?

11. Why do you think plants live on the log?

MAKING A WATERSCOPE

Activity: Making a waterscope to observe plants and animals under water.
Concept: Many living things grow underwater.

This activity is both fun and interesting for students. You may wish to have individual students complete the project or have the whole class undertake it.

Directions for Students:

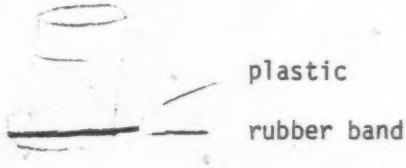
Materials Needed to Make Waterscope

- 1 large can (#10)
- hammer
- flat black paint
- cellophane or plastic
- rubber bands

1. Remove the top and bottom from a can. Pound the edges of the can with a hammer to make them smooth.

2. Paint the inside of the can with flat black paint and allow it to dry. This reduces reflection.

3. Attach a piece of plastic over one end of the can with a rubber band.



4. To use the waterscope, place the covered end of the can beneath the surface of the water.

Try searching along a pond bank or lake shore for underwater plants and animals. Make drawings of what you see.

Students may wish to refer to books and try to identify the kinds of plants and animals.

Some other ideas to investigate at the pond - Any signs of pollution? Other kinds of activity?

(Adapted from: Outdoor Education Equipment. Danville, Illinois: The Interstate Interstate Printers and Publishers, Inc., 1974.)

MISCELLANEOUS ACTIVITIES

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NATURE'S PART IN ART

Activities: Some ideas on combining nature and art activities.

Special Note: The teacher's guide, Nature's Part in Art is included in the kit and forms the basis of these activities. Please read and refer to it for the following activities.

These activities are intended to give children a closer look at their environment. The children can explore various aspects of this environment by collecting natural objects for art projects. All the activities listed below are explained in great detail in Nature's Part in Art. You may wish to choose one or several projects for your students to pursue. Have fun!

	ACTIVITIES	PAGE REFERENCE: (Nature's Part in Art)
I.	Plant Dyes A. Dyeing wool B. Making batiks	4
II.	Printing A. Blueprints B. Pattern Printing C. Shadow Tracing	5-7
III.	Displaying Natural Materials A. Collage B. Centerpiece C. Imaginative Creatures D. Terrariums	8-10
IV.	Sand Casting	10
V.	Structures A. Grain Stalks or Straw B. Mobiles	11-12
VI.	Sand Painting	12
VII.	Soil Painting	13
VIII.	Dried Plant Arrangements	14
IX.	Stone Structures	14
X.	Litter	15
XI.	Man's Use of Natural Items in Design	15

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Extending the Activities (Large-scale project): An Environmental Arts Fair

Your class, as well as other classes in the school, might wish to sponsor an environmental arts and crafts show. As a part of the show, arts and crafts could be displayed, demonstrations given on making environmental crafts, and mini-lessons taught on the environment. Some areas to include might be:

1. Arts and Crafts.
   Some of the items created in above activities.
   Environmental cooking, dance, music-songs about man and nature.

2. Creative Writing.
   Student works comparing natural and man-made objects.
   Poetic forms and styles (sometimes the poem takes the shape of the object being described.)

3. Sensory Awareness.
   Using senses, other than just sight, to identify and appreciate man-made and natural materials; for example: a "Smell the Earth" exhibit.

4. Photographic Studies.
   Displays of photographic art.
   Essay pictures similar to the book The Family of Man.
   Slide/tape presentations. (see activity on slide show)
   Double exposure displays showing opposites in natural and man-made objects, in human experiences, and in social phenomena.

SLIDE/TAPE SHOWS

Concept: Man has an effect on his environment.

Activity: Making a slide/tape show about problems in your community.

Students can learn a great deal about the environmental problems of their own local communities by making a slide/tape show. This show might be shown to other students, members of the community, as well as the local governing body to generate interest and concern to local problems.

Students will need to identify local problems and record them on film and coordinate a script.

Materials Needed:

Cameras (Available upon request)
Film
Tape recorder
Slide projector

Any slide/tape shows that are produced by students might be included in the CBE kit to be shown to other students. Please let CBE know if your students undertake this project.

(120)

ENVIRONMENTAL CHARADES

Concept: Man has created various kinds of environmental pollution.

Activity: Playing Environmental Charades.

Activity:

Before class write on separate strips of paper the following pollution sentences such as the following: you are litter on the highways; you are a fish dying from lack of oxygen; you are human sewage polluting a river; you are a fish filled with poison such as mercury; you are an automobile with a very dirty, poisonous exhaust; you are a litterbug; you are the last living member of a species; you are a harmful pesticide. (The teacher may want to supplement or alter these.)

Divide the class into small groups of 3 or 4 students. A random method (such as "counting off") might be used.

Explain that each group will become whatever is written on their strip of paper. All have to do with environmental problems caused by man. They will be given five minutes to develop a pantomine that will enable the rest of the students to guess what they are. The students can do anything but talk.

When five minutes have elapsed, let each group present its charade to the rest of the class. You may want to time how long it takes for the class to guess each group's identity.

Discussing the Activity:

1. Ask the students if they found it difficult to communicate their ideas without being able to talk and listen.

2. Why is it necessary for environmentalists to be able to have sharp or keen senses? They should realize that environmental problems are usually seen or smelled. (A dead fish or poisonous exhause won't show its presence!)

(128)

Extending the Concept:

As a followup, students might want to develop their own environmental problems to pantomine. They also might wish to invent an environmental game of 20 questions.

(Adapted from: Environmental Science Study Project. Man and His Environment, P.S. Jones Junior High School, Washington, D.C. 27889.)

REFERENCES AND BIBLIOGRAPHY

SOURCES OF PREPARED ENVIRONMENTAL EDUCATION CURRICULUM MATERIALS FOR TEACHERS

AIR POLLUTION CONTROL ASSOCIATION - 4400 Fifth Ave., Pittsburgh, Pa., 15213: "Air Pollution Experiments for Junior and Senior High School Science Classes." (1969) $1.00/copy.

AMERICAN EDUCATION PUBLICATIONS - Education Center, Columbus, Ohio 43216: "Focus on Pollution" ecology series with teacher guidelines. Designed for upper elementary-junior high. Includes experiments.

AMERICAN FOREST INSTITUTE - 1619 Massachusetts Ave., N.W., Washington, D.C. 20036: "Learn to Love Trees", a sample of teaching units prepared by the Institute for Elementary Teachers. Single copies free. Quantity copies .05 each.

AMERICAN LUNG ASSOCIATION - Contact your local branch as listed in your telephone directory for information and curriculum suggestions on air pollution and health. Guide available free of charge. K-12.

THE CENTER FOR CURRICULUM DESIGN - P.O. Box 350, Evanston, Ill., 60204: "You are an Environment" teaching-learning activities designed to develop environmental attitudes. Send for catalog which includes price information for curriculum, films and books.

CONCERN, INC. - 2100 M. St., N.W., Washington, D.C. 20037: Copies of "Eco-Tips" available on a number of environmental/ecological topics. Examples include "Solid Waste," "Over-Packaging," "Automobile Pollution" and "Consumer Guidelines." Published in pamphlet form $5.00/100.

CONSERVATION AND ENVIRONMENTAL STUDIES CENTER - Box 2230 R.D. 2, Brown Mills, New Jersey, 08015: A multidisciplinary approach in curriculum design. Includes background information, activities and resources. Sample units include: "Land Use", "Water, the Waste of Plenty," "Angling for an Unknown Direction." Good for use in mathematics classes, Junior High and up. $1.50 each.

EAST SYRACUSE - MINOA - Environmental Education Project Coordinator, Administration Building, 407 Fremont Rd., East Syracuse, N.Y., 13057: Science and Social Studies curriculum guide, K-12. Divided into elementary, Middle School and High School. Complete listings of concepts, corresponding activities and resources. Individual grades .50-1.00. Total curriculum package: $8.00.

ECOLOGY CENTER OF ANN ARBOR - Environmental Education Coordinator, 417 Detroit St., Ann Arbor, Michigan 48104: Designed curriculum available on Organic Gardening, Energy, Transportation, Solid Waste and Basic Ecological Concepts. Resource materials available for free-loan. .10/unit.

ENVIRONMENTAL ACTION COALITION - ECO-NEWS - 325 E. 49th St., N.Y. N.Y., 10017: Children's newsletter accompanied by corresponding teacher's guide. Individual issues devoted to single topic areas such as: recycling, trees, population and solid waste. Very reasonably priced.

ENVIRONMENTAL SCIENCE CENTER - 5400 Glenwood Ave., Golden Valley, Minnesota 55422: Curriculum materials designed for middle school-adult. Science oriented with experiments. Sample units include: "Transect Studies," "Life Forms and Soil," "Soil Testing and Sampling," "Nature Hunt," "Outdoor Activities," "Population," and "Micro-Climates." Prices vary from .50-$1.00/unit.

ERIC - Center for Science, Mathematics and Environmental Education. 1800 Cannon Dr., 400 Lincoln Tower, Ohio State University, Columbus, Ohio 43210: A resource service organized by topic areas and grade levels. Sample environmental education materials include: "A Review of Environmental Education for Teachers of Urban/Disadvantaged" and "100 Activities for Environmental Education." Both $3.50.

THE GARDEN CLUB OF AMERICA - Conservation Committee, 518 Madison Ave., N.Y., N.Y., 10022: Conservation oriented curriculum suggestions and audio-visual aids on Birds, Wildlife and Conservation. K-6 Free.

GIRL SCOUTS - ECO-ACTION PROJECT BOOKS - Girl Scouts of Metropolitan Detroit, 153 E. Elizabeth St., Detroit, Michigan 48002: Especially designed curriculum materials for Girl Scouts but suitable applications for elementary classes. Three successive guidebooks and corresponding Leader's Guides introduce ecology and progress to problem-solving and action projects. Write for price information.

J.G. FERGUSON PUBLISHING CO., - 6 N. Michigan Ave., Chicago, Ill., 60602: "People and their Environment" conservation education curriculum guides for teachers, grades 1-12. Include sources of materials and bibliography of books and films. Volumes $3.95 each or 3 or more volumes, $3.50 each.

KEEP AMERICA BEAUTIFUL - 99 Park Ave., N.Y., N.Y. 10016: Litter prevention and other pollution control projects for high school students. Sample titles include: "Litter Laws" and "71 Things You Can Do to Stop Pollution." Free.

NATIONAL AUDUBON SOCIETY - 1150 5th Ave., N.Y., N.Y. 10022. Curriculum guidelines related to birds, wildlife and nature study. High quality. Consult local branches for price information or write for catalog of education materials.

NATIONAL EDUCATION ASSOCIATION - Sales Section, 1201 Sixteenth St., N.W., Washington, D.C. 20036: "Man and His Environment - An Introduction to Using Environmental Study Areas." Designed to acquaint teachers with new ideas and practices that focus on an interdisciplinary approach to environmental education. Book and filmstrip combination. $1.75. (Publications catalog available.

NATIONAL WILDLIFE FEDERATION - Educational Services Division, 1412 16th St., N.W., Washington, D.C. 20036: Many educational publications, including written curriculum guidelines and Action leaflets on endangered species, Wildlife of farm and field, Wildlife of forests and rangelands, Wildlife of lakes marshes and streams. .10/copy. NWF is also the publisher for Minnesota Environmental Science Federation, Inc. - Environmental Discovery Units available on "Plants in the Classroom," "Oaks, Acorns, Climate and Habitat," "Man's Habitat: The City," and "Vacant Lot Studies," as examples. Elementary level. $1.00 - 1.50.

NORTH JERSEY CONSERVATION FOUNDATION - 300 Mendham Rd., Morristown New Jersey 07960: "Education for Survival: Ecology in Science and Social Studies." An interdisciplinary approach designed with concept pages, facts and classroom activities. Also included are charts and diagrams. Teacher's guides accompany the 4 volume set, arranged sequentially grades 1-6. Volumes vary in price from $4.00 - 6.00.

P.A. SCHILLER AND ASSOCIATES - P.O. Box 306, Chicago, Ill., 60690 "Knock the Four Walls Down." Inexpensive teaching units in environmental education. Investigations include "In Search of the Sun and the Water", "Creative Writing," "Food Chains," "Streams - all Water?," and "Touch in the Environment." Elementary and junior high. Vary in price from $.35 - .50.

PENNSYLVANIA DEPARTMENT OF EDUCATION - Science Education Advisor, Bureau of General and Academic Education, Box 911, Harrisburg, Pa., 17126: "Reprints of Environmental Instructional Activities" K-6 and 7-12. Spaceship earth concepts. Also, "Science, Nature and the Survival of Man," a non-science environment course for secondary students. Both include background information, activities, and bibliographical information.

PENNSYLVANIA TUBERCULOSIS AND RESPIRATORY DISEASE ASSOCIATION - 311 S. Juniper St., Philadelphia, Pa., 19107: "Our Polluted Air - A Teacher's Guide for a Mobile Workshop." Six lesson plans, complete with flannel board kit. Designed to help elementary school students comprehend the nature of the air pollution problem and the possibilities for a solution. $45.00 East of the Mississippi; $50.00 West of the Mississippi.

PROJECT SEE - Wyandotte Public Schools, 891 Goddard Rd., Wyandotte, Michigan 48192: GREEPS, on insects, making compost, energy and air pollution. Lower elementary through adult.

RODALE PRESS - Educational Services Division, Emmaus, Pa. 18049: "Environmental Education the Organic Way" a series of activities and educational materials tying environmental education to an organic trend in living. Single units on the following: "Best Ways to Improve Your Soil," "Handbook of Composting," "Teaching Science with Garbage," "The Organic Classroom," "Basic Organic Gardening Course," "Teaching Science with Soil," and the "Organic Living Series." K-9. Single units $1.50.

SCIENCE CURRICULUM IMPROVEMENT STUDY - Published by Rand McNally, 405 Park Ave., N.Y., N.Y. 10022: Teacher guidelines and curriculum activities arranged in a series on the following topics: Populations, Environmental Cycles, Ecosystems, Community and Life cycles, Excellent experiments and classroom activities. $1.50 each.

SOIL CONSERVATION DISTRICT - 6101 Jackson Rd., Ann Arbor, Michigan 48103: Curriculum materials on Food, Land, Water, Soil and Outdoor Classrooms on School Sites. Elementary. Free. (Also information on attracting wildlife.)

U.S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE - Washington, D.C. 20250: Curriculum units on "Forest Succession," "Forest Diseases," and "Forest Products," as examples. Conservation teaching aids mainly designed for elementary. Girl Scouts Newsletter available, with corresponding teacher guides. Free.

SOIL CONSERVATION SOCIETY OF AMERICA - 7515 N.E. Ankeny Rd., Ankeny, Iowa 50021: "Environmental Quality and the Citizen - A Teaching Guide for Adult Education Courses Related to the Environment." Single copies: $2.00, postpaid; 2-10 $1.50 ea., 11-99 $1.25 ea; 100 or more $1.00 ea., pp.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY - most publication available through United States Government Printing Office, Washington, D.C. 20402: "The Processing and Recovery of Jon Thomas Cool Cat" and "There Lived a Wicked Dragon" coloring and activities books for children on Solid Waste. $.55 each. Legislative summaries and pollution control laws also available.

UNITED STATES FOREST SERVICE - E. Region, Milwaukee, Wisconsin, 53203: "Investigating Your Environment Series" A sensitivity awareness and problem-solving approach for upper elementary students through adults. Units on soils, forests, water, wildlife and outdoor activities. Experiments included. Free.

WEBSTER-McGRAW-HILL BOOK COMPANY - Manchester Rd., Manchester, Mo., 63011: "Elementary Science Study." Complementary teacher's guides, problem cards and student kits on these sample topics: "Growing Seeds," "Micro-gardening," "Pond Water," and "Rocks." Available in classroom quantities. Reasonably priced.

XERO POPULATION GROWTH - Population Reference Bureau, Inc. 1755 Massachusetts Ave., N.W., Washington, D.C. 20036: "The World Population Dilemma," a textbook on population designed for elementary and secondary students. Part of a series entitled "This Crowded World" (grades 4-6) and "People" (grades 7-9). World and U.S. population data in chart form also available. Free.

INFORMATION AGENCIES AND ORGANIZATIONS

Listed below are agencies and organizations that are good sources for information. Many of the groups listed below also produce newsletters and provide free or inexpensive materials.

Air Pollution Control Assoc. Publications
4400 Fifth Avenue
Pittsburg, PA 15213

American Assoc. of University Women
2401 Virginia Ave., N.W.
Washington, D.C. 20007

American Assoc. for Conservation Information
1416 Ninth Street
Sacramento, CA 95814

American Cancer Society
219 East 42nd St.
New York, N.Y.

American Conservation Association
30 Rockefeller Plaza
New York, N.Y. 10020

American Forestry Assoc.
919 17th St., N.W.
Washington, D.C. 20006

American Forest Institute, Ed. Div.
1835 K St., N.W.
Washington, D.C. 20006

American Petroleum Institute
School Program
1271 Avenue of the Americas
New York, N.Y. 10020

Association of Interpretive Naturalists
1251 East Broad St.
Columbus, Ohio 43205

Boy Scouts of America
National Council
New Brunswick, New Jersey 00903

Bureau of Outdoor Recreation
U.S. Dept. of the Interior,
Division of Information
19th and C Sts. N.W.
Washington, D.C. 20240

Bureau of Solid Waste Management
Environmental Control Admin.
Consumer Protection and Environmental Health Services
Arlington, Virginia 22203

Bureau of Sport Fisheries and Wildlife
Fish and Wildlife Services
Washington, D.C. 20240

Citizens for Clean Air
40 W. 57th St.
New York, N.Y. 10019

Citizens League Against the Sonic Boom
19 Appleton Street
Cambridge, Massachusetts 02138

Committee for Environmental Information
433 N. Skinker Blvd.
St. Louis, MO 63130

Conservation and Environmental Science Center
Box 2230, R.D. #2
Browns Mills, New Jersey 00025

Conservation Education Association
Wilson F. Clark, President
Eastern Montana College
Billings, Montana 59101

The Conservation Foundation
1250 Connecticut Ave., N.W.
Washington, D.C. 20036

Ecological Society of America
Radiation Ecology Section
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831

Environmental Action Coalition, Educational Services
235 E. 49th Street
New York, N. Y. 10017

Environmental Science Services Admin.
U.S. Department of Commerce
Rockville, Maryland 20852

Federal Water Pollution Control
Administration
Crystal Mall., Bldg. 2
1921 Jefferson Davis Hwy.
Arlington, Virginia 22203

Forest Service, U.S. Dept. of Agri.
Information and Education
Room 3223 S. Agriculture Bldg.
Washington, D.C. 20250

Friends of the Earth
30 E. 42nd Street
New York, N.Y. 10017

The Garden Club of America
598 Madison Avenue
New York, N.Y. 10022

International Union for Conservation
of Nature and Natural Resources
2000 P St., N.W.
Washington, D.C. 20006

The Izaak Walton League of America
1326 Waukegan Road
Glenview, Ill. 60025

John Muir Inst. for Env. Studies
451 Pacific Ave.
San Francisco, CA 94133

Keep America Beautiful, Inc.
99 Park Avenue
New York, N.Y. 10016

League of Woman Voters of the U.S.
1200 17th St., N.W.
Washington, D.C. 20036

National Air Pollution Control Admin.
Consumer Protection & Env. Health Ad.
Arlington, Virginia 22203

National Audubon Society
1130 Fifth Avenue
New York, N.Y. 10028

National Conference on State Parks
1700 Pennsylvania Ave., N.W.
Washington, D.C. 20006

National Council of State Garden Clubs
4401 Magnolia Street
St. Louis, MO 63110

National Parks Association
1701 18th St., N.W.
Washington, D.C. 20009

National Science Teachers Assoc.
1201 16th St., N.W.
Washington, D.C. 20036

National Tuberculosis & Respiratory
Disease Assoc., Materials Devel.
1740 Broadway
New York, N.Y. 10019

National Wildlife Federation
1412 16th St., N.W.
Washington, D.C. 20036

National Youth Conference on Natural
Beauty and Conservation
c/o Girl Scouts of the U.S.A.
830 Third Avenue
New York, N.Y. 10022

The Nature Conservancy
1522 K St., N.W.
Washington, D.C. 20006

Oceanographic Education Center
Box 585
Falmouth, MA 02541

Planned Parenthood World Population
515 Madison Avenue
New York, N.Y. 10022

Population Council, Inc.
230 Park Avenue
New York, N.Y. 10017

Resources for the Future
1755 Mass. Ave., N.W.
Washington, D.C. 20036

Scientists' Institute for Public
Information
30 E. 68th Street
New York, N.Y. 10021

Sierra Club
1050 Mills Tower
San Francisco, CA 94104

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Soil Conservation Service
Washington, D.C. 20250

Sport Fishing Institute
Suite 503
719 13th St., N.W.
Washington, D.C. 20006

Student Conservation Assoc.
Sagamore Hill Nat. Historical Site
Mld. Rt. Box 304
Oyster Bay, N.Y. 11771

United States Forest Service
Washington, D.C. 20250

Urban American
1717 Massachusetts Ave., N.W.
Washington, D.C. 20036

The Wilderness Society
729 15th St., N.W.
Washington, D.C. 20005

Zero Population Growth
367 State Street
Los Altos, CA

Box 259 Village Station
New York, N.Y. 10014

Recommended Library Books

Adams, Kramer. The Redwoods. Popular Library: 1970.
What the redwoods are and are not; who uses them and how; what the wood is like; prospects for the longevity of the forests. (9-adult)

Allen, Durward L. The Life of Prairies and Plains. McGraw-Hill Book Co.: New York, 1967. (Our Living World of Nature Series)

Atz, James W. Aquarium Fishes: Their Beauty, History, and Care. Viking Press: New York, 1971.

Baker, Jeffrey. The Vital Process: Photosynthesis. Doubleday & Co., Inc.: New York, 1969.
Elementary, but clear.

Bates, Marston. Man in Nature. Prentice-Hall: Englewood Cliffs, 1961.
Reference book for good readers showing man's place in nature.

Borror, Donald J. and White, Richard E. Field Guide to the Insects of America North of Mexico. Houghton-Mifflin: Boston, 1970. (Peterson Field Guide Series)

Bronson, William. How to Kill a Golden State. Doubleday: New York, 1968.
Excellent photographs showing man's effects on the state of California. Good reference.

Burt, William H., and Grossenheider, Richard P. A Field Guide to the Mammals. Houghton-Mifflin: Boston, 1964. (Peterson Field Guide Series)

Carson, Rachel. Silent Spring. Houghton-Mifflin: Boston, 1962.
Classic book telling of the effects of pesticides on the environment.

Chandler, T. J. The Air Around Us. Natural History Press: Garden City, 1969.

Chinery & Larkin. Patterns of Living: Foundations of Ecology. Ginn & Co.: Boston, 1966.
Good library reference book. Good pictures and easy to understand text.

Cohen, Daniel. How Did Life Get There? Messner: 1973.
A thought-provoking book on dispersal of plants and animals centered on the isolated volcanic islands of Krakatoa, Surtsey, and the Galapogos, and on the island continent of Australia.

Commoner, Barry. Science for Survival. Ballantine: 1966.
Emphasis is on the interrelatedness of all factors in our environment. (9-adult)

Costello, David F. The World of the Ant. J.B. Lippincott: New York.
Part of "Living World Series." Shows life history of the ant, classification, and man's effect on it.

Costello, David F. The World of the Prairie Dog. J.B. Lippincott: New York. Part of "Living World Series." Shows life history of the prairie dog, classification, and man's effect on it.

Dahlberg, Charles Clay. From Food to Fertilizer: The Role of Excrement in the Life Cycle. Young Scott (Addison-Wesley): 1973.
The role of human and animal wastes in life cycles. Uses of animal wastes as fertilizers, in sewage disposal systems, as useful bacteria. The human digestive and urinary systems are included. Important information which is not easily available elsewhere.

Darling, Lois and Louis. A Place in the Sun. Morrow and Co.: New York, 1968.

Davies, Delwyn. Fresh Water. Natural History Press: Garden City, 1969.

DeBell, Garrett. The Environmental Handbook. Ballantine Books: New York, 1970.

Dudley, Ruth. Partners in Nature. Funk & Wagnall Co.: New York, 1965.
Discusses symbiosis, giving many interesting examples. Easy to read but challenging.

Earle, Olive L. Scavengers. Morrow: 1973.
Describes the appearance and behavior of insects, mammals, and birds that perform a valuable function in nature. Material not easily found elsewhere about an important aspect of ecology.

Edelson, Edward, and Warshofsky, Fred. Poisons in the Air. Pocket Books: New York, 1966.

Farb, Peter. Ecology. Time, Inc.: New York, 1963.

Farb, Peter. The Land and Wildlife of North America. Time, Inc.: New York, 1966. (Life Nature Library)

Gabb, Michael and Chinery, Michael. The Life of Animals Without Backbones: Foundations of Invertebrate Zoology. Sampson Low, Marston and Co.: London, 1966.

Graham, Frank Jr. Since Silent Spring. Houghton-Mifflin: Boston, 1970.
Follow-up book to Silent Spring which tells what has happened to the pesticide problem since Rachel Carson's book was published. (Good readers)

Harrison, C. William. Conservationists and What They Do. Watts: New York, 1963.

Harrison, Hal H. The World of the Snake. J.B. Lippincott Co.: New York. Part of "Living World Series." Shows life history of the snake, classification, and man's effect on it.

Jaffe, Joyce. Conservation. Natural History Press: Garden City, 1970.
Excellent reference on history of conservation, basic ecology, extinct and endangered animals, wildlife management, and overpopulation.

Keefe, James. The World of the Oppossum. J.B. Lippincott: New York.
Part of "Living World Series." Tells of oppossum habits through each season and effect of man on the opposum.

Lass, William and Beicos, S.S. (Dr.). The Water in Your Life. Popular Library: 1967.
In 14 brief chapters, covers almost all the topics associated with water.

Laycock, George. Animal Movers: A Collection of Ecological Surprises. Natural History Press: Garden City, 1971.

Laycock, George. Water Pollution. Grosset and Dunlap, Inc.: New York, 1972.
Good reference on water pollution, elementary reading level.

Laycock, George. Wild Animals, Safe Places. Four Winds: 1973.
A fascinating account of four unique places (Yellowstone National Park, Mt. McKinley National Park, Hawaiian Islands National Wildlife refuge, and the Everglades National Park) where wild creatures are safe from threats of man. Brief but precise accounts of animals found in each of these regions are included. Excellent photographs.

Laycock, George. Wild Refuge. Natural History Press: Garden City, 1969.
Excellent book about National Wildlife Refuges.

Laycock, George. The World's Endangered Wildlife. Grosset & Dunlap: 1973.
Many little-known as well as familiar animals are presented with reasons for their near-extinct status. List of concerned organizations, bibliography, and index included. A dispassionate and sincere plea for conservation.

Levi, Herbert W., and Lorna R. A Guide to Spiders and Their Kin. Golden Press: New York, 1968. (Golden Nature Guide)

Longgood, William. The Poisons In Your Food. Pyramid Books: New York, 1960.
Shocking book telling about food additions and other chemicals used in the food processing industry.

Marx, Wesley. The Frail Ocean. Coward McKann, Inc.: New York, 1967.
Reference book for good readers warning of the problems in the ocean. Gives several examples of specific damage done by man.

McHarg, Ian L. Design With Nature. Natural History Press: 1969.
Beautiful reference book showing man's impact on his environment. Includes information on urban design and city planning.

McNulty, Faith. Must They Die? Doubleday: New York, 1971.
Superb story of disappearance of the prairie dog and black-footed ferret. Somewhat difficult reading.

Mitchell, Robert T., and Zim, Herbert S. Butterflies and Moths. Golden Press: New York, 1964.

Navarra, John G. The World You Inherit: A Story of Pollution. Doubleday: 1970.
Clearly written story of causes and problems of pollution.

Park, Ed. The World of the Bison. J.B. Lippincott: New York.
Part of "Living World Series." Shows life history of the bison, classification, and man's effect on it.

Park, Ed. The World of the Otter. J.B. Lippincott: New York.
Part of "Living World Series." Shows life history of the otter, classification, and man's effect on it.

Petrides, George A. A Field Guide to Trees and Shrubs. Houghton-Mifflin Co.: Boston, 1958. (Peterson Field Guide Series)
Field marks of all trees, shrubs, and woody vines that grow wild in the Northeastern and North-Central United States and in Southeastern and South-Central Canada.

Pringle, Laurence. Ecology: Science of Survival. MacMillan Publishing Co., Inc.: New York, 1971.

Pringle, Laurence. One Earth, Many People. MacMillan: 1971.
Summary of the "facts" of population growth. (9-12)

Pringle, Laurence. The Only Earth We Have. MacMillan, 1970.
Specific names and addresses of conservation groups, nature societies, control boards, and state departments are given. Well-written, easy-to-read, and generously illustrated with pictures, drawings, carcoons, and photographs. (7-12)

Raskin, Edith. The Pyramid of Living Things. McGraw-Hill: New York, 1967.

Robertson, Keith. In Search of a Sandhill Crane. Viking: 1973.
In this novel, a young teenager from New Jersey spends a summer in the wilds of the Upper Peninsula of Michigan where his persistence pays off in getting pictures of sandhill cranes. In so doing, he learns much about the beauty and drama of nature, and the significance of conservation.

Rue, Leonard Lee, III. The World of the Beaver. J.B. Lippincott: New York.
Part of "Living World Series." Shows life history of the beaver, classification, and man's effect on it.

Rue, Leonard Lee, III. The World of the Red Fox. J.B. Lippincott Co.: New York.
Part of "Living World Series." Shows life history of the red fox, classification, and man's effect on it.

Rue, Leonard Lee, III. The World of the White-Tailed Deer. J.B. Lippincott: New York.
Part of "Living World Series." Shows life history of the white-tailed deer, classification, and man's effect on it.

Rutler, Russel J. and Pimlott, Douglas H. The World of the Wolf. J.B. Lippincott: New York.
Part of "Living World Series." Shows life history of the wolf, classification, and man's effects on it.

Schisgall, Oscar. That Remarkable Creature, the Snail. Simon & Schuster: New York, 1970.

Schoonmaher, W.J. The World of the Grizzly Bear. J.B. Lippincott: New York. Part of "Living World Series." Shows lifehhistory of the grizzly bear, classification, and man's effect on it.

Shuttlesworth, Dorothy. Animal Camouflage. Natural History Press: New York, 1966.
Well-written and easy to read book on animals and their ability to protect themselves. All kinds of animal camouflage are described.

Simon, Hilda. Partners, Guests and Parasites. Viking Press: New York, 1970.
Interesting and well-written.

Simon, Seymour. Discovering What Crickets Do. McGraw-Hill: 1973.
Crickets' anatomy, life cycle, song; their individual and group life are all examined in this book. Simon also discusses more fanciful accounts of crickets. Simple observational experiments are interwoven in the text.

Stebbins, Robert C. A Field Guide to Western Reptiles and Amphibians. Houghton-Mifflin: Boston, 1966. (Peterson Field Guide Series)
A field guide to western reptiles and amphibians; field names of all species in North America.

Storer, John H. The Web of Life. Signet Books: 1953.
Excellent story of life in a community. Shows effects of physical factors on living community.

Swatek, Paul. Users' Guide to the Protection of the Environment. Ballantine Books: 1970.

Teal, John and Mildred. Life and Death of the Salt Marsh. Ballantine Books: 1969.
Good reference on salt marshes. (8-12)

VanWormer, Joe. The World of the American Elk. J.B. Lippincott: New York. Part of "Living World Series." Shows life history of the black bear, classification, and man's effect on it.

Wright, Robert. What Good is a Weed?: Ecology in Action. Lothrop, Lees & Shepard Co.: no date
Interesting reading, elementary reading level.

Zim, Herbert S., and Shoemaker, Hurst H. Fishes. Golden Press: New York, 1956. (Golden Nature Guide)

Zim, Herbert S., and Ingle, Lester. Seashores. Golden Press: New York, 1961. (Golden Nature Guide)

B2

Recommended Audio-Visual Aids

FS (sound filmstrip)
FL (filmloop)
MM (Multi-media kit)

Investigations in Ecology: A Biological Approach. A set of six filmstrips or six slide carousels. Denoyer-Geppert. (FS)

Ecological Systems Group I: Ecology of a Seashore, Forest, Pond, and Desert. Imperial Film Corporation (FS)

The Deciduous Forest. Warren Schloat Inc. (FS)

Ecology at Work: The Case of the Bighorn Sheep. Warren Schloat Inc. (FS)

What Is Ecology? Warren Schloat Inc. (FS)

The Ecological Crisis. A set of six filmstrips: Population Statistics, Population Trends, Some Ecological Considerations, Evolution and Extinction, Pesticides, Pollution. SVE Educational Corp. (FS)

Ecology At Work: A Study of the Sea Otter. Warren Schloat Inc. (FS)

Clearwater: A Dream for a River as Told by Pete Seeger. Denoyer-Geppert (FS)

The People Problem. Guidance Associates (FS)

Environment: Changing Man's Values. Guidance Associates (FS)

Air Pollution. Warren Schloat (FS)

Small Worlds of Life. National Geographic (FS)

Kingdom of the Animals. Includes Africa, Insects, Reptiles, Chimpanzees, Wildlife. National Geographic (FS)

This World of Energy. National Geographic (FS)

The Oceans. Warren Schloat (FS)

The Story of the Everglades. Warren Schloat (FS)

Water Pollution. Warren Schloat (FS)

Air Pollution. Scott-Thorpe. Filmstrips and Transparencies (MM)

Water Pollution. Scott-Thorpe. Filmstrips and Transparencies (MM)

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